

Copernicus FICE 2025

Training on
In situ Ocean Colour Above-Water Radiometry towards Satellite Validation

ThoMaS match-up toolkit

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EUMETSAT



6-20 July 2025
Venice, Italy





- What's ThoMaS? Scope
- Some background
- Usage
- Pre-requisites
- Getting the code
- Setting the environment
- Required inputs
- Run the code: examples



ThoMaS is a toolkit developed to create **matchups** of biogeophysical **insitu data** with **satellite ocean colour products** from **Sentinel-3 OLCI (S3/OLCI)**.

in SeaBASS format

Standard products from NASA's OBPG also supported
Others easily configurable, if netCDF or series of netCDFs



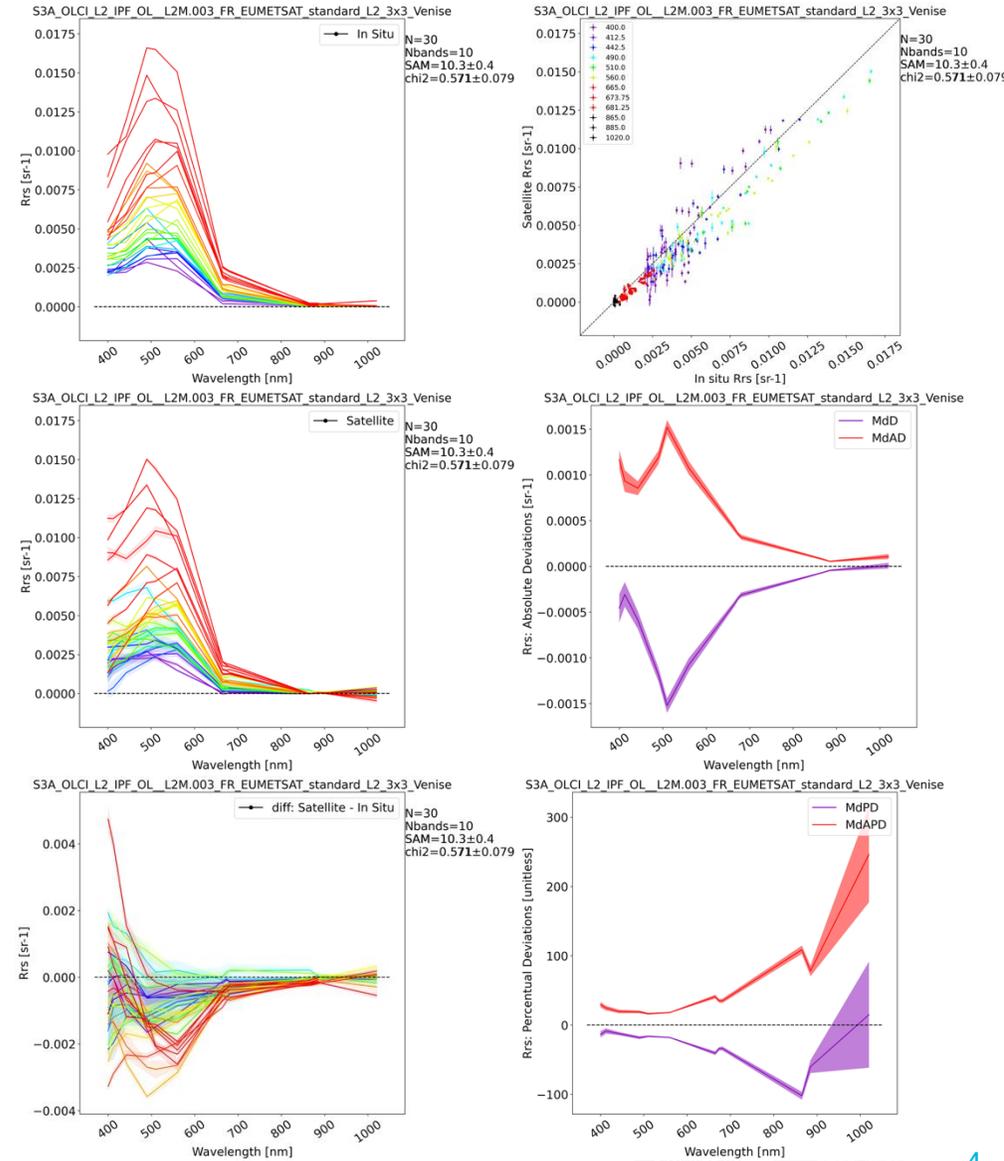
→ EUMETSAT colleague and friend Thomas Flament gave the name to the code after a joke



What's ThoMaS? Scope

After running **ThoMaS**, you will get:

- **In situ** data “transformed” to **match satellite** (spectral convolution, band-shifting, spectral reconstruction, BRDF...).
- **Satellite** data (L1B – TOA radiance - or L2 – BOA water reflectance) from **EUMETSAT Data Store** and **NASA OBPG** (reprocessed/operational) matching spatially/temporally your insitu.
- **Extractions** of satellite data centred at lat/lon of insitu of user-defined size (3x3, 5x5..).
- **Statistics of extractions** following EUMETSAT’s or any user-defined **matchup protocol**.
- **Merging of simultaneous** (spatially-temporally) **insitu-satellite pairs**, **temporal interpolation**, and **statistics of matchups**.
- **Outputs:**
- **NetCDF 4** files: SatData, minifiles, Extraction Data Base files, In situ Data Base file, Matchup Data Base files.
- **CSV**: summarizing satellite extraction statistics and matchup statistics.
- **PNG**: Standardised output plots.





- Essentially Juan is developing the code, but:
- Ilaria Cazzaniga (JRC) and Malcolm Taberner (EUMETSAT) developed the first match-up database workflow at EUMETSAT. Took many ideas and the main concept from this.
- Ewa Kwiatkowska and David Dessailly continuously support the development and the concept.
- Hayley Evers-King and Ben Loveday (EUMETSAT) contribute a lot to the code consolidation, user support, training, jupyter notebooks, and testing
- Eleni Kalogeraki (ECMWF) developed the first version of the GUI as part of a 6-month internship at EUMETSAT.
- Anna E. Wyndle di Paola, James G. Allen and Dirk Aurin (NASA) contributed to incorporate PACE.
- Frederic Melin (JRC) ran a preliminary verification with his own independent matchup workflow with identical results.
- Testers:
 - Pietro Sciuto (JRC)
 - The FICE 2024 and 2025 trainees 😊



1. Well documented, suited also for a first approach to the matchup exercise for those who are new to the matchup exercise.
2. It's publicly available, free and open to scrutiny: it serves for the purpose of converging to a standard matchup practice.
3. It supports the most commonly used matchup protocols in the OC community.
 - e.g. of existing ones: EUMETSAT's, Bailey & Werdell 2006, Zibordi 2009, Copernicus SVC_VIS
 - Versatile: new matchup protocols can be easily added via configuration files.
 - It contains an easy syntax to create new quality flags based on simple relations between products.
4. It deals (under some assumptions) with propagation of uncertainties to the performance metrics (using a Monte-Carlo approach).
5. Already supports some of the most commonly used OC satellite missions
 - Currently supports Sentinel-3 (standard) L1B, L2, MODIS L2 (standard), VIIRS L2 (standard), SeaHawk L2 (standard) and PACE L2 (standard)
 - Versatile: new types of satellite products can be easily added via configuration files (depending on mission, processor and processing baseline).



ThoMaS is still not fully validated and is still under development ...

copernicus.eumetsat.int

1. If you use it to run your match-up exercise, you are responsible to verify the results! Reporting back and working with us on improvements and troubleshooting is appreciated.
2. The policy of garbage-in garbage-out applies to ThoMaS: you must know well your insitu data, the satellite product, and make sure that you are comparing “apples” to “apples”. Also, that your satellite pixels are sufficiently away from land, and rationally choose your extraction size, time difference tolerance, among many others.
3. ThoMaS does not deal with uncertainties coming from spatial and temporal collocation of insitu and satellite data beyond very standard QC (e.g. a maximum time tolerance window, a choice of window size, and a simple temporal interpolation). In other words, the problem of spatial and temporal autocorrelation of the Rrs signal (and any other OC product) is not yet dealt within ThoMaS.
4. ThoMaS cannot still compute match-up statistics of a given insitu-satellite set with varying satellite extraction sizes.
5. The uncertainty of the satellite component is only based on the inter-pixel variability (pixel-by-pixel uncertainties in the satellite component are still ignored in ThoMaS).
6. The uncertainties of the BRDF step are not propagated.
7. ThoMaS won't do an A/C of your satellite data!
8. Many other disclaimers (working on many of these 😊), but I hope it still proves useful!

- What is a match-up according to **ChatGPT** [2023]?

j Hi ChatGPT

🌀 Hello! How can I assist you today?

j Could you define me "match-up" in the realm of Earth Observation?

🌀 In the context of Earth Observation, "match-up" refers to the process of comparing satellite data to ground-based measurements or other reference data sources to assess the accuracy and quality of the satellite observations.

Match-up analysis is typically used to validate satellite measurements of various geophysical parameters, such as surface temperature, vegetation cover, sea surface temperature, and atmospheric aerosols, among others. The ground-based measurements can be obtained from various sources, such as ground-based sensors, buoys, weather stations, or other types of in-situ measurements.

Ocean colour



Of course we have much more to define... and take care of...

- What is a match-up according to **ChatGPT [2025]**?

Hi there! 😊 How can I help you today?



Can you define a "match-up" in the realm of Earth

Certainly!

In the realm of **Earth Observation (EO)**, a "match-up" refers to a **coincidence or alignment of more datasets—typically from different sensors, platforms, or measurement techniques—that share the same target (usually a specific location on Earth) at nearly the same time and under comparable conditions.**

More formally:

A **match-up** is a spatiotemporal pairing between measurements (e.g., satellite, airborne, in-situ data) that allows for direct comparison, validation, calibration, or data fusion.

Key Components of a Match-up:

- 1. Spatial Collocation**
The observations must refer to the same geographic area, often defined within a specific radius or pixel size.
- 2. Temporal Collocation**
The observations must occur within a defined time window (e.g., within ± 1 hour) to ensure the measured environmental conditions are consistent.
- 3. Measurement Comparability**
The observed quantities should be comparable (e.g., Sea Surface Temperature, Aerosol Optical Depth), with harmonized units and possibly corrected for known biases or differences in measurement geometry.

Common Use Cases:

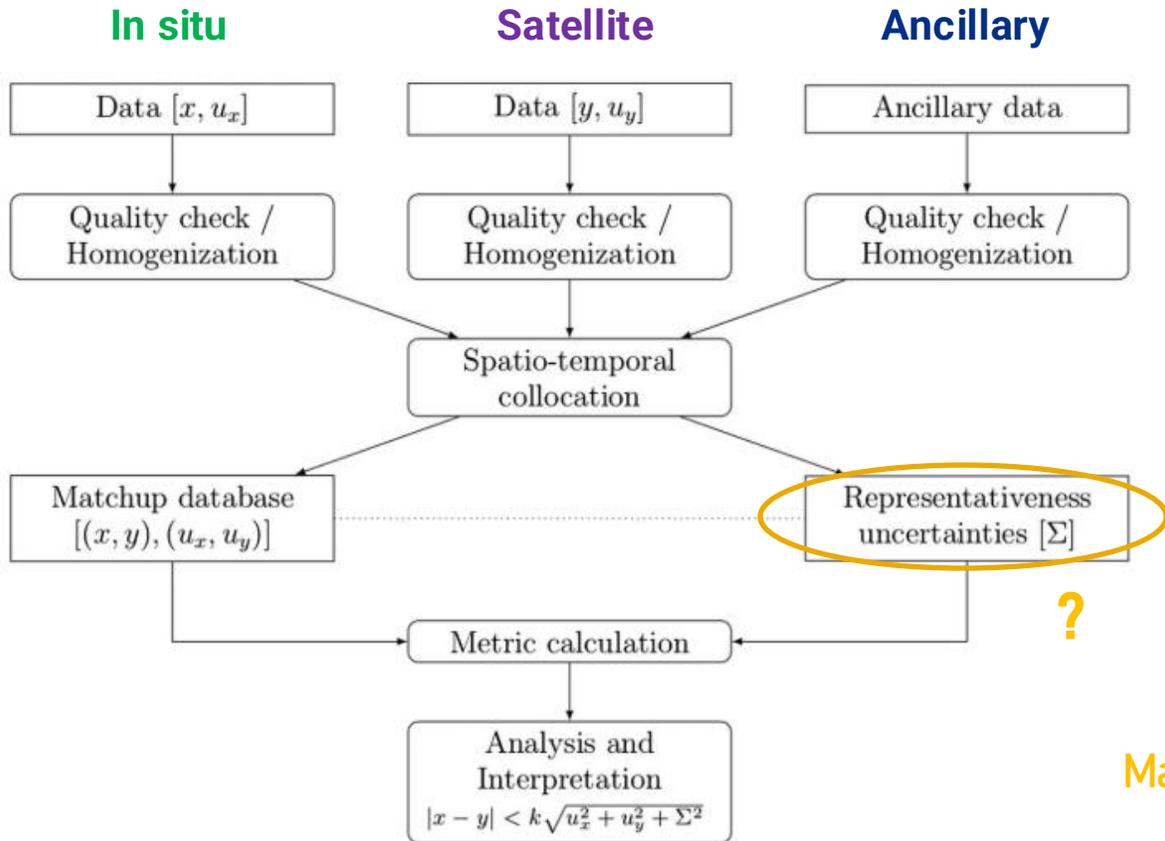
- **Satellite vs. In-situ Validation** 
Comparing satellite data (e.g., ocean color) with ground-truth data from buoys or ships.
- **Sensor Intercomparison**
Matching data from two different satellites to ensure consistency (e.g., MODIS vs. VIIRS).
- **Data Assimilation and Fusion**
Combining different observations (e.g., satellite  odel outputs) to improve spatial/temporal coverage and accuracy.



Some background: match-ups

- The EO data are in practice rarely fully traceable, for instance, because fundamental calibrations done in the laboratory prelaunch **cannot be repeated in space**.
- Consequently the **comparison against reference measurements** in a validation exercise is often the only way to link the EO data back to an agreed standard.

[Loew et al. 2017]



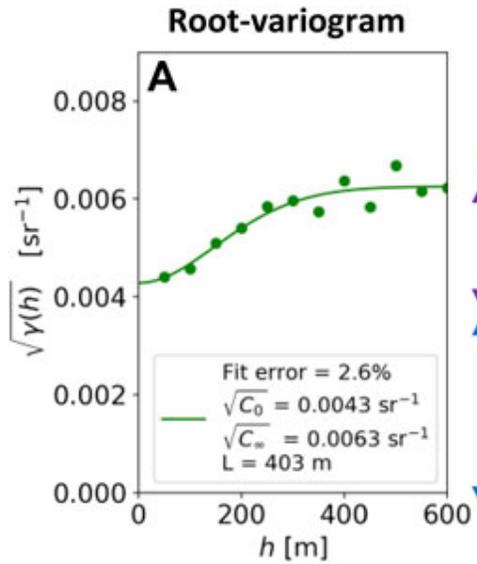
x = “reference” measurement (in situ)
 u_x = insitu uncertainty

y = EO measurement (satellite)
 u_y = satellite uncertainty

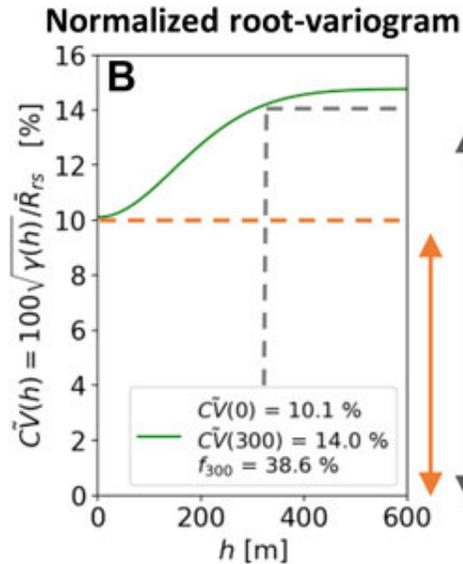
Representativeness

The extent to which a set of measurements taken in a given space-time domain reflect the actual conditions in the same or different space-time domain
 [Nappo et al., 1982]

Matchup protocols in OC deal (still sub-optimally) with this...



Total spatial variation: $\sqrt{C_\infty - C_0}$
Total variation: $\sqrt{C_\infty}$
Intrinsic variation: $\sqrt{C_0}$

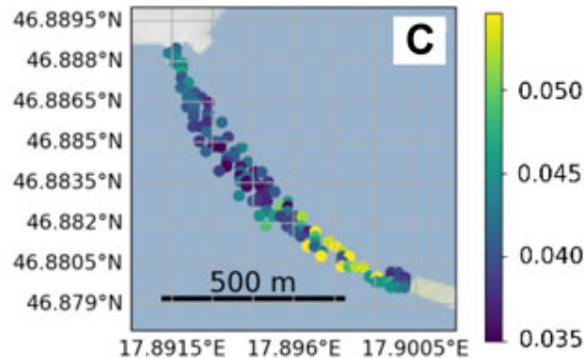


Normalized variation at 300 m
Normalized intrinsic variation

Jordan et al. 2023

Autocorrelation length (L)

In situ reflectance: $R_{rs}(560)$

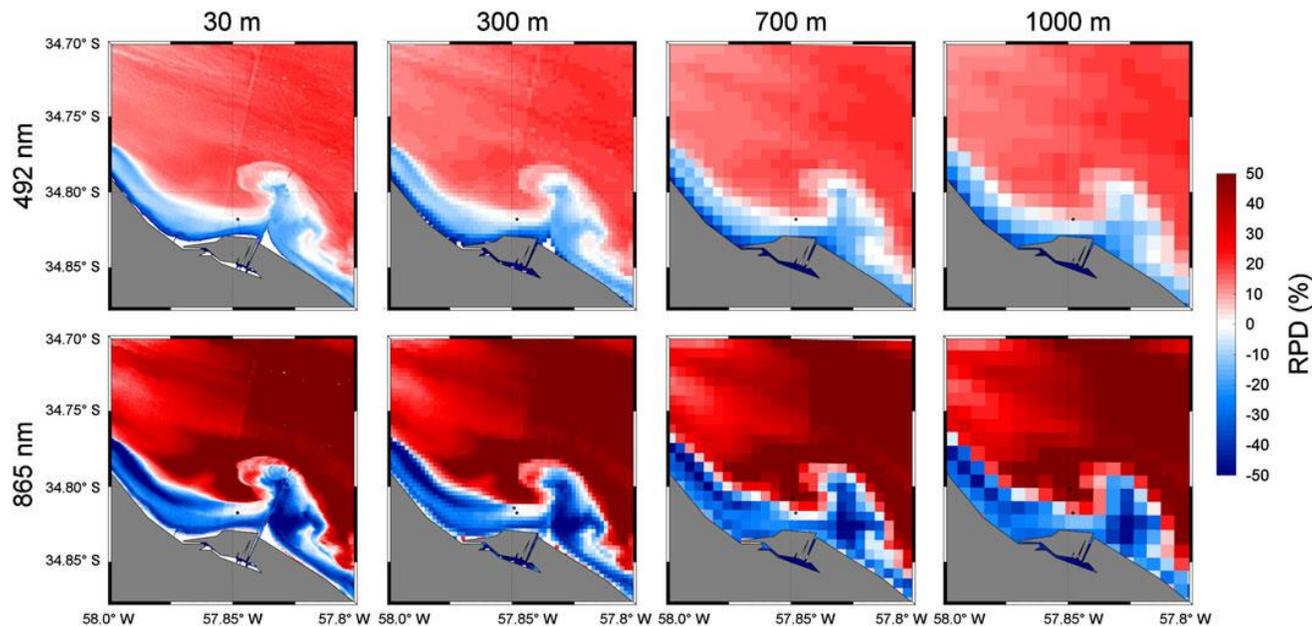


Representativeness

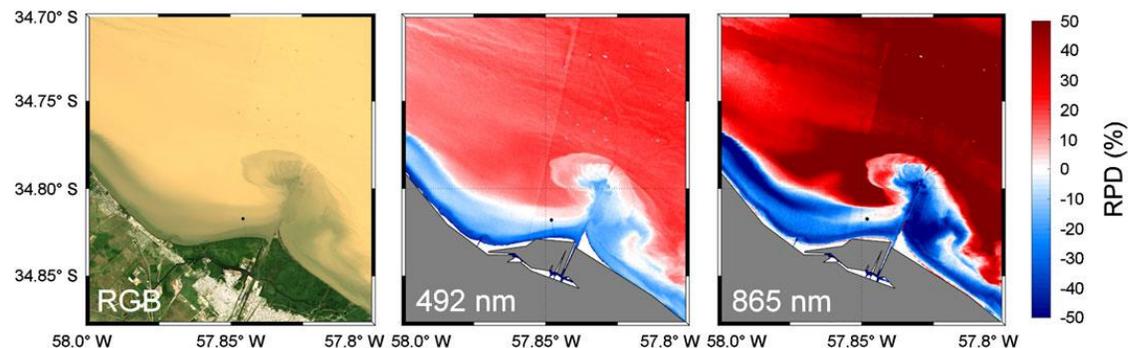
The extent to which a set of measurements taken in a given space-time domain reflect the actual conditions in the same or different space-time domain
[Nappo et al., 1982]



Some background: match-ups, a note on spatial/temporal homogeneity



Dogliotti et al. 2024

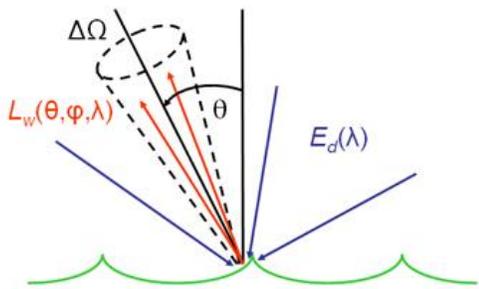


Representativeness

The extent to which a set of measurements taken in a given space-time domain reflect the actual conditions in the same or different space-time domain
 [Nappo et al., 1982]

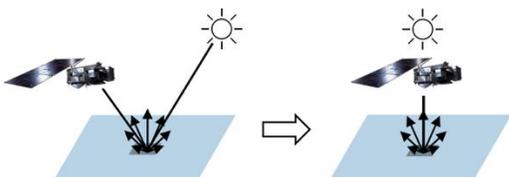
Definition of Rrs

$$R_{rs}(\theta, \phi, \lambda) \equiv \frac{L_w(\text{in air}, \theta, \phi, \lambda)}{E_d(\text{in air}, \lambda)} \quad (\text{sr}^{-1})$$



OO Web Book, Mobley, Boss & Roesler

BRDF correction:



D'Alimonte et al.

Morel et al. 2002 supported in ThoMaS

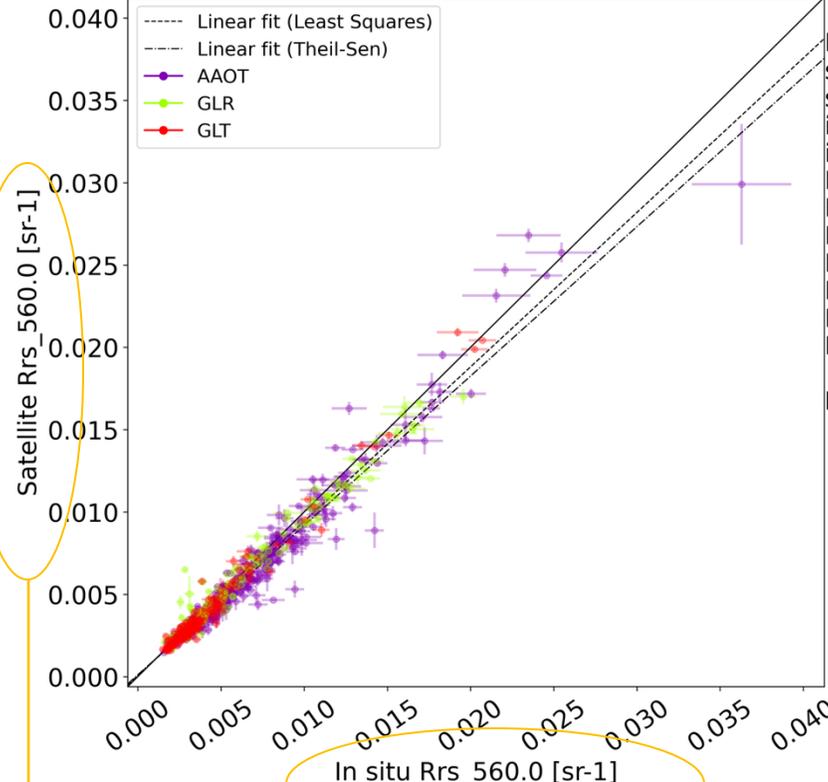
Are we comparing 🍎 with 🍎?

→ What is the definition of Rrs?

→ Are these two compatible "spectrally"? → convolution/band-shifting

→ Are these two compatible "directionally"? → BRDF correction

3A_OLCI_L2_IPF-Coll4_OL_L2M.004_FR_EUMETSAT_standard_L2_3x3_Optically_Complex



N=792
 slope=0.938±0.015
 slope_TS=0.9074±0.0053
 intercept=0.00006±0.00008
 intercept_TS=0.00011±0.00005
 R2=0.9738±0.0034
 MdD=-0.00025±0.00002
 MdAD=0.00041±0.00001
 MdAPD=9.20±0.29
 MCFk1=0.5
 MCFk2=0.85
 MCFk3=0.97

MdPD=-5.51±0.3

Band-shifting (to pair multispectral to multispectral)

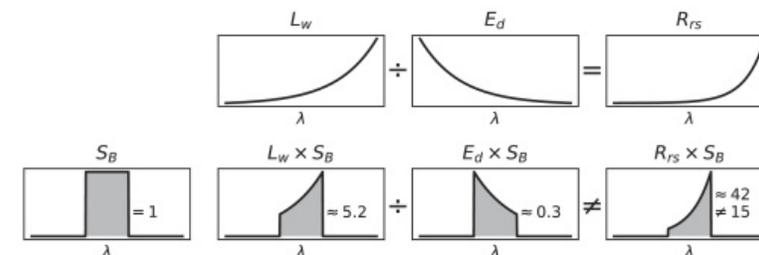
$$R_{RS}^e(\lambda_i \rightarrow \lambda_t) = R_{RS}^f(\lambda_t) \frac{R_{RS}(\lambda_i)}{R_{RS}^f(\lambda_i)}$$

Melin & Sclep 2015 supported in ThoMaS

PACE: Spectral reconstruction

Talone, Zibordi, Pitarch 2024, recently added

Spectral convolution



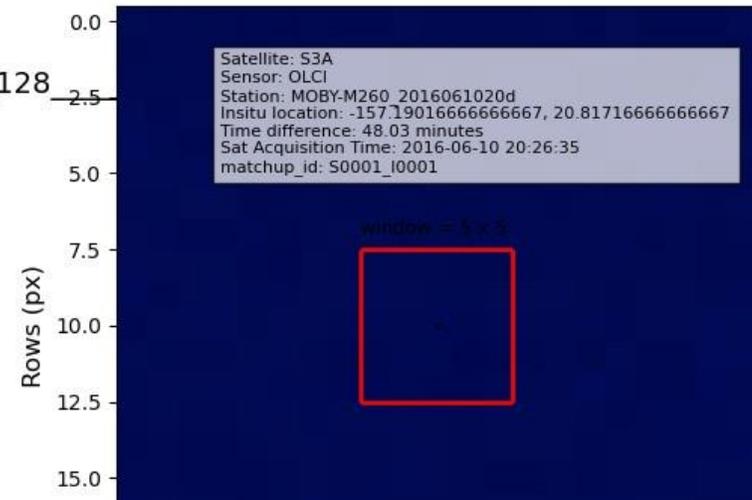
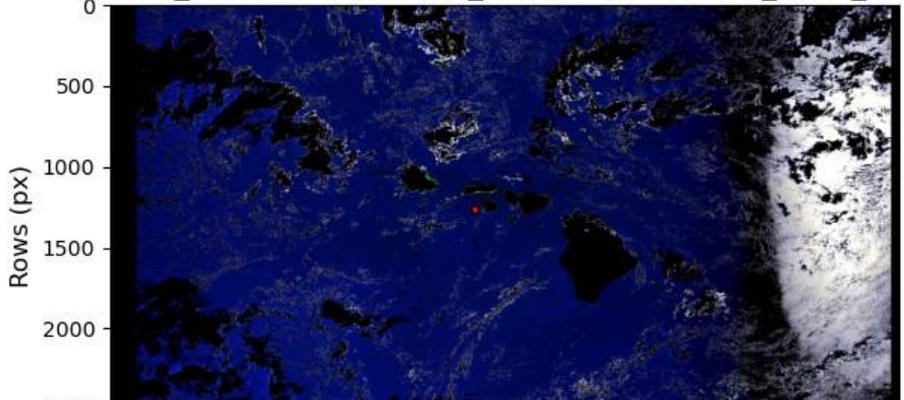
Burggraaff 2020



Some background: match-ups, a note on BRDF correction

S3A_OL_2_WFR___20160610T202635_20160610T202835_20210706T132838_0119_005_128

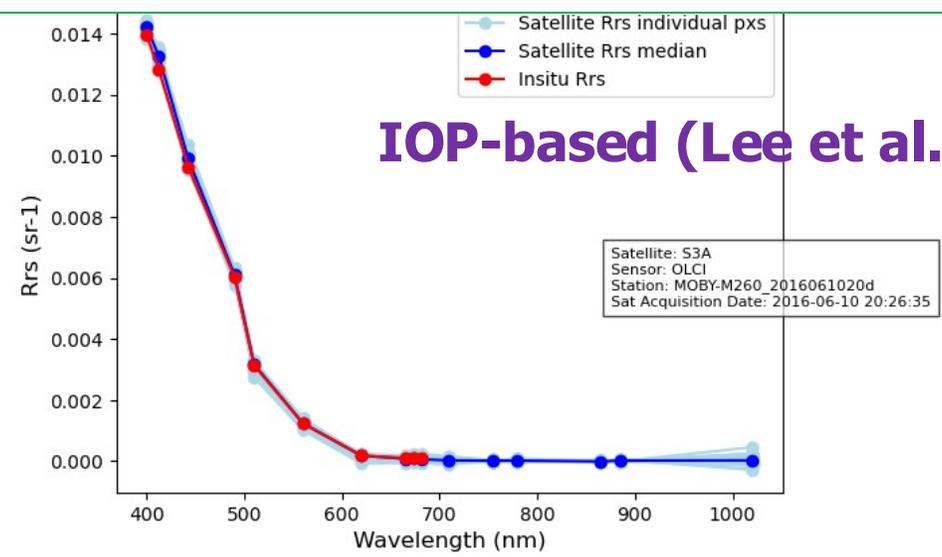
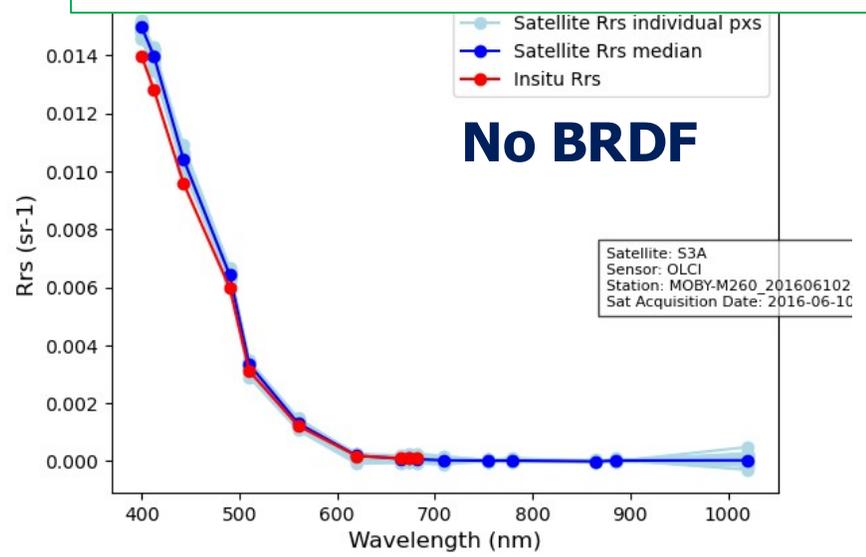
RGB Image in sensor geometry



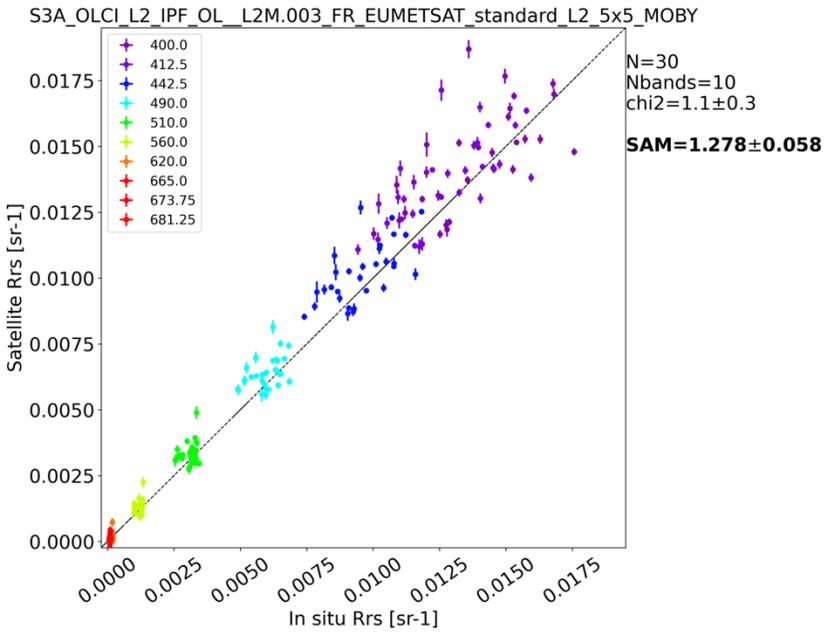
Visit BRDF study webpage

<https://www.eumetsat.int/brdf-correction-s3-olci-water-reflectance-products>

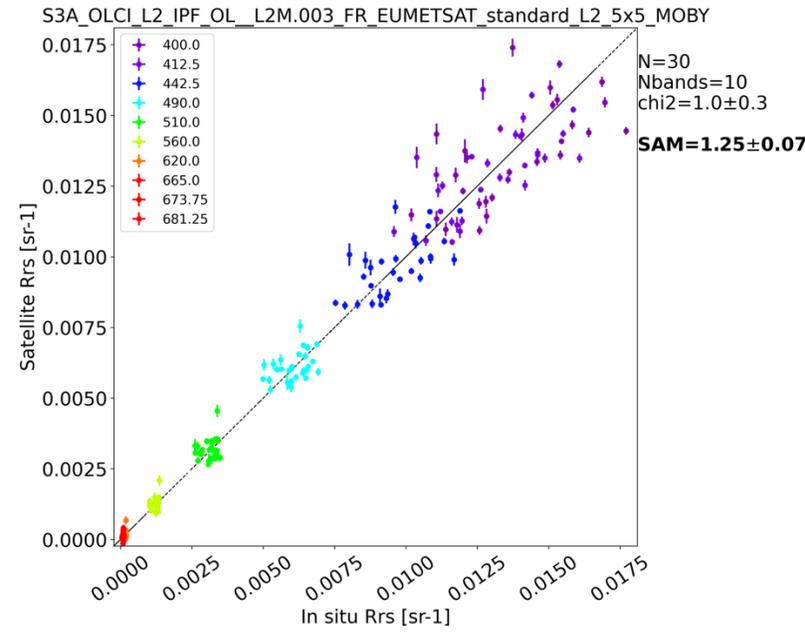
Rrs for satellite a



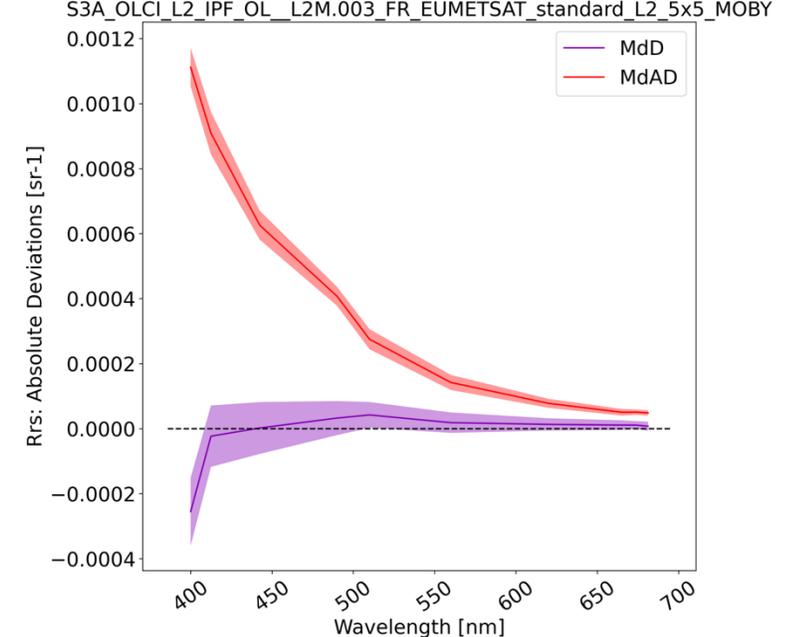
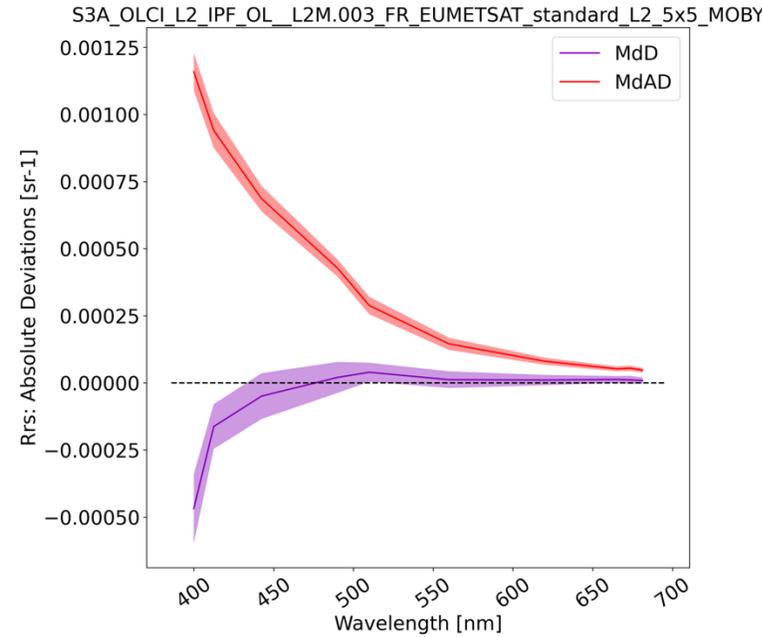
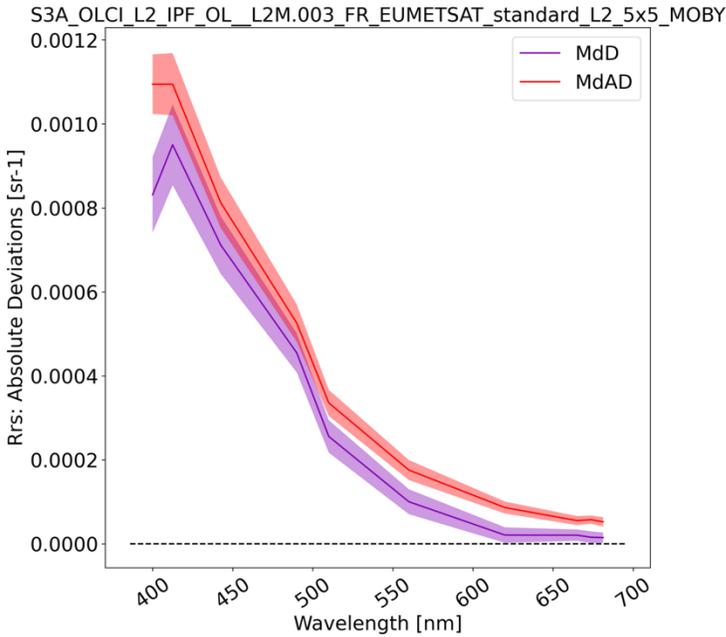
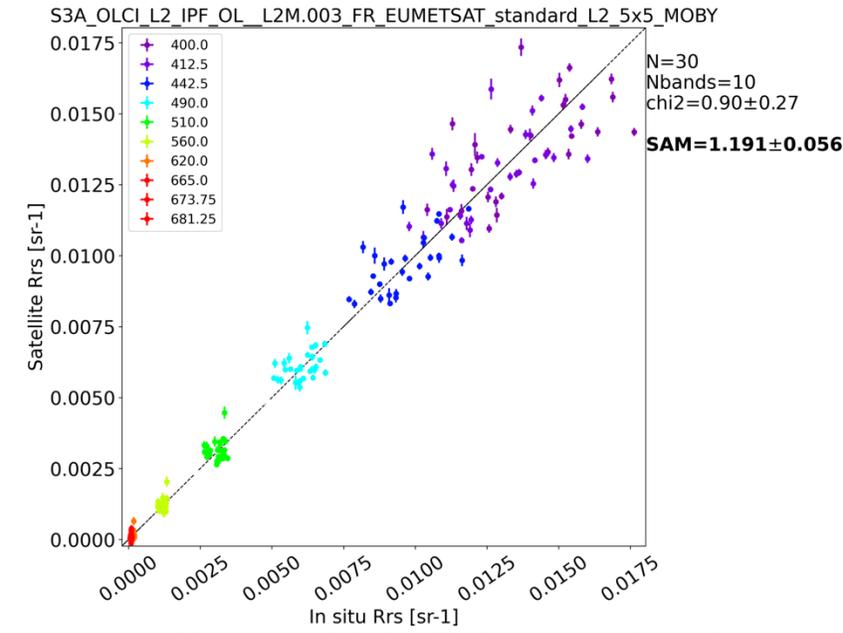
noBRDF



Morel et al. 2002 (R.f/Q)



Pitarch et al. 2025 (O25)



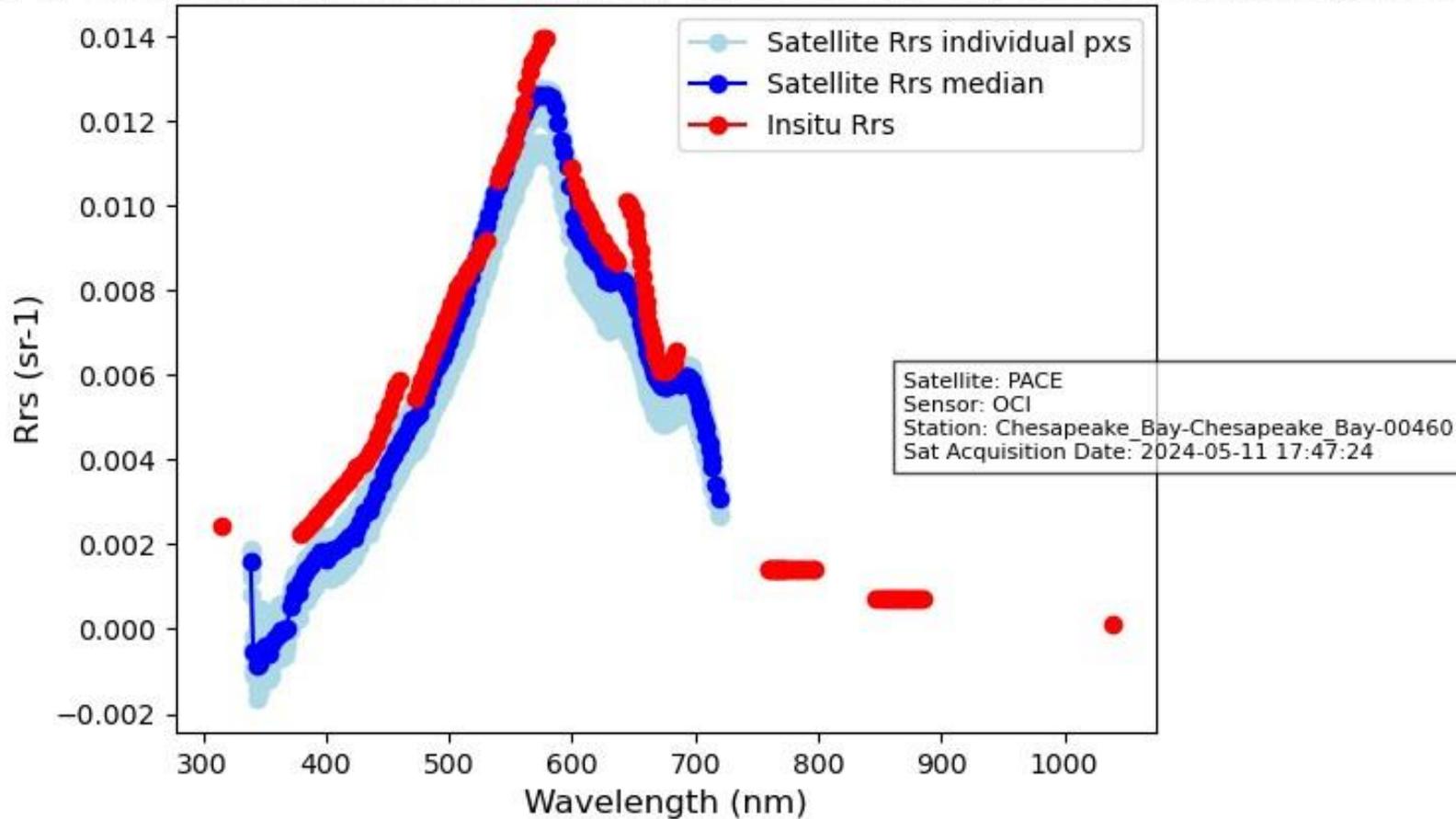


Some background: match-ups (spectrally matching insitu to satellite)

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Melin & Sclep 2015 band-shifting method not applicable for hyper 2 hyper spectral matching

Rrs for satellite and in-situ (Station: Chesapeake_Bay-Chesapeake_Bay-00460, matchup_id: S0022_I0461)



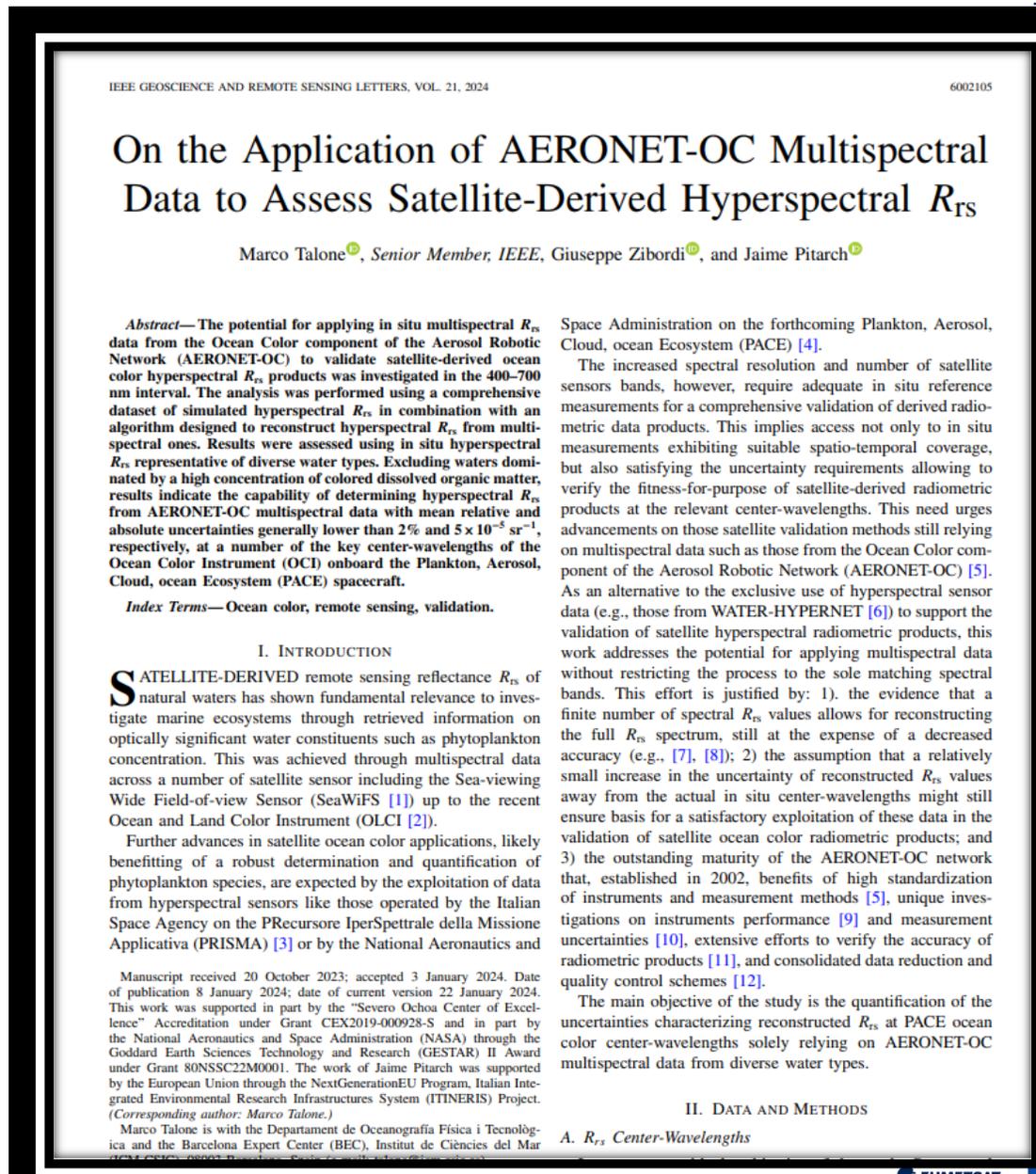


Tried Talone, Zibordi and Pitarch 2024 method

This method:

1. Finds the best 3 matches from a set of exhaustive hyperspectral Hydrolight simulations, using a selected set of multispectral bands.
2. Establishes a blending approach in a way that the resulting reconstructed spectrum coincides exactly with the insitu original spectrum at the original multispectral bands and takes the spectral dependence of these best 3 matches in the intermediate “query” bands.

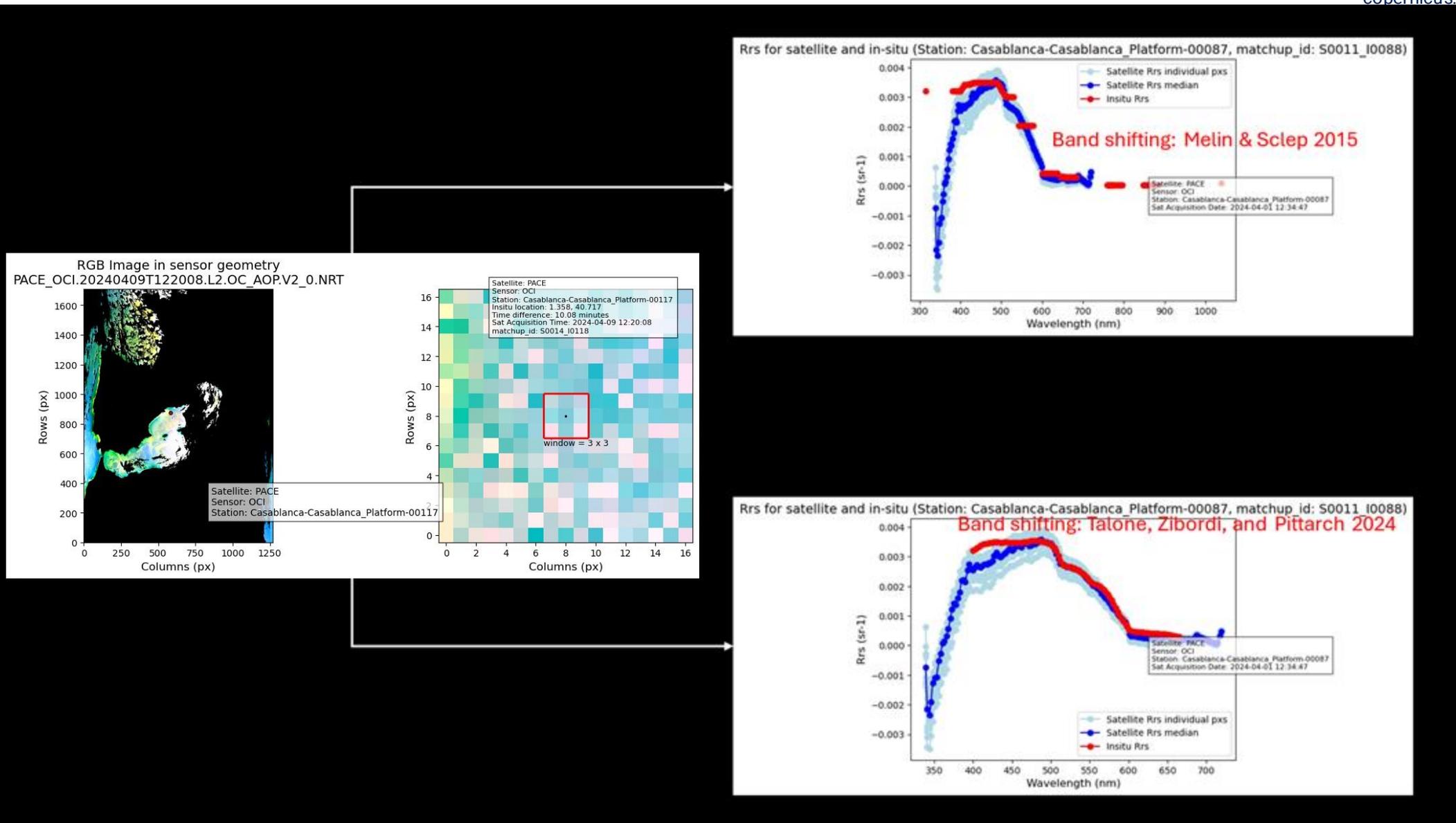
Validated with a concurrent hyperspectral in situ instrument, showing relative differences typically < 5 % between modelled and measured values.





Some background: match-ups (spectrally matching insitu to satellite)

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Some background: match-ups

Quality of insitu

Define your extraction statistics!

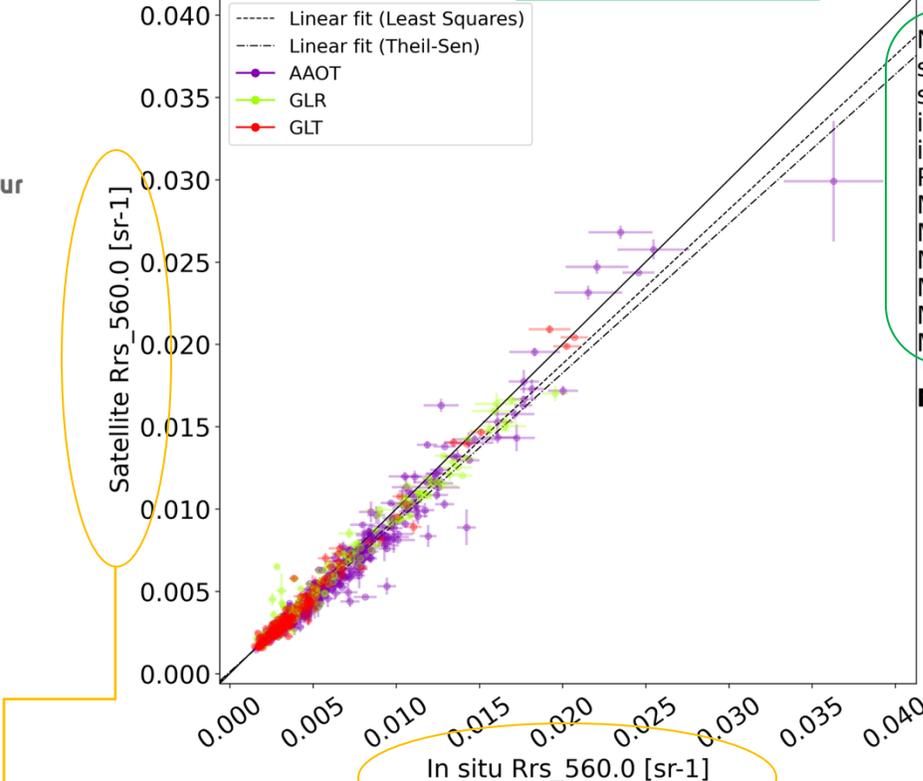
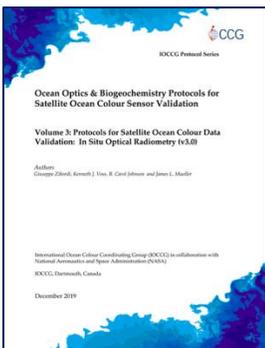
Define your extraction window size!

ThoMaS doesn't do an "FRM check" of the submitted in situ

S3A_OLCI_L2_IPF-Coll4_OL_L2M.004_FR EUMETSAT_standard_L2 3x3 Optically_Complex



fiducial reference measurements for satellite ocean colour

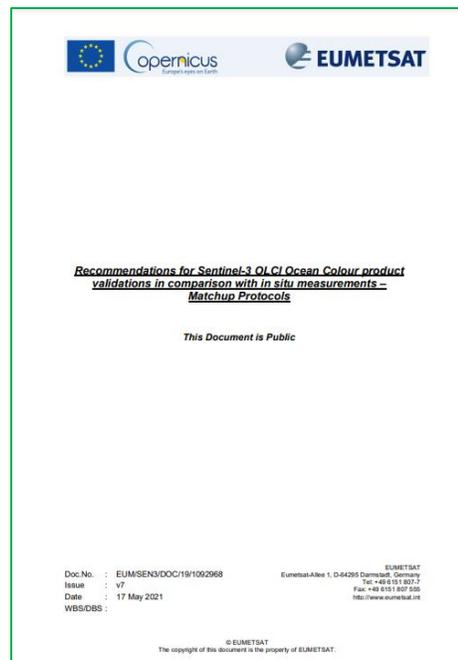


N=792
 slope=0.938±0.015
 slope_TS=0.9074±0.0053
 intercept=0.00006±0.00008
 intercept_TS=0.00011±0.00005
 R2=0.9738±0.0034
 MdD=-0.00025±0.00002
 MdAD=0.00041±0.00001
 MdAPD=9.20±0.29
 MCFk1=0.55
 MCFk2=0.85
 MCFk3=0.97

MdPD=-5.51±0.36

Define the matchup statistics!

EUMETSAT's Matchup Protocols



Are we comparing 🍓 with 🍓?

- Are the insitu measurements of sufficient quality?
- Are insitu and satellite measurements temporally-spatially comparable?
- What value (and uncertainty) shall I extract from the satellite data?



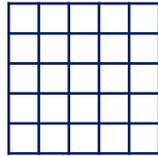
Some background: match-ups: EUMETSAT extraction protocol

EUMETSAT's Matchup Protocols: extraction of statistics at macropixel level

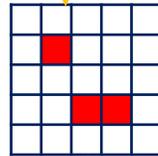
Window size recommended: **5x5** or **3x3**

Tolerable insitu-satellite time difference: **1 hr** or **3 hrs**

Set BFOR: 5x5 window



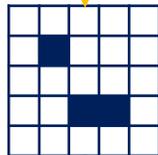
Detection of non-valid pixels (flagged pixels)



Pixels are masked/removed if flagged by any of the following:

CLOUD, CLOUD_AMBIGUOUS, CLOUD_MARGIN, INVALID, COSMETIC, SATURATED, SUSPECT, HISOLZEN, HIGHGLINT, SNOW_ICE, AC_FAIL, WHITECAPS, ADJAC, RWNEG_O2, RWNEG_O3, RWNEG_O4, RWNEG_O5, RWNEG_O6, RWNEG_O7, RWNEG_O8

Set BOR: without flagged pixels



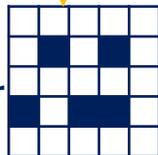
Macropixel is discarded if:

$$N_{BOR} < 50\% N_{BFOR}$$

Pixel 'X' is considered outlier if:

$$|value@X - \mu_{BOR}| < 1.5\sigma_{BOR}$$

Set final: without flagged & outlier



Central value: median_{final}
Uncertainty measure (Type B): σ_{final}
Homogeneity measure: CV_{final}

Macropixel is discarded if:

$$CV_{final}(560) > 20\%$$

$\mu \rightarrow$ Mean
 $\sigma \rightarrow$ Standard deviation

ThoMaS can be run with many other extraction protocols, that you define



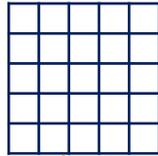
Some background: match-ups: Bailey & Werdell protocol

EUMETSAT's Matchup Protocols: extraction of statistics at macropixel level

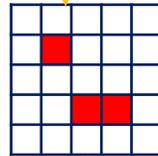
Window size recommended: **5x5** or **3x3**

Tolerable insitu-satellite time difference: **1 hr** or **3 hrs**

Set **BFOR**: 5x5 window



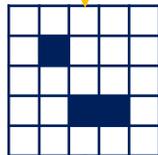
Detection of non-valid pixels (flagged pixels)



Pixels are masked/removed if flagged by any of the following:

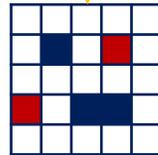
ATMFAIL, LAND, HIGLINT, HILT, HISATZEN, STRAYLIGHT, CLDICE, COCCOLITH, HISOLZEN, LOWLW, CHLFAIL, NAVWARN, MAXAERITER, CHLWARN, ATMWARN, SEAICE, NAVFAIL, ABSAER, MODGLINT

Set **BOR**: without flagged pixels



Macropixel is discarded if:

$$N_{BOR} < 50\% N_{BFOR}$$



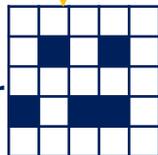
Pixel 'X' is considered outlier if:

$$|value@X - \mu_{BOR}| < 1.5\sigma_{BOR}$$

Macropixel is discarded if:

$$\text{Median}[CV(Rrs(410-551)); CV(AOT(869))] > 15\%$$

Set **final**: without flagged & outlier



Central value: $median_{final}$
Uncertainty measure (Type B): σ_{final}
Homogeneity measure: CV_{final}

$\mu \rightarrow$ Mean
 $\sigma \rightarrow$ Standard deviation

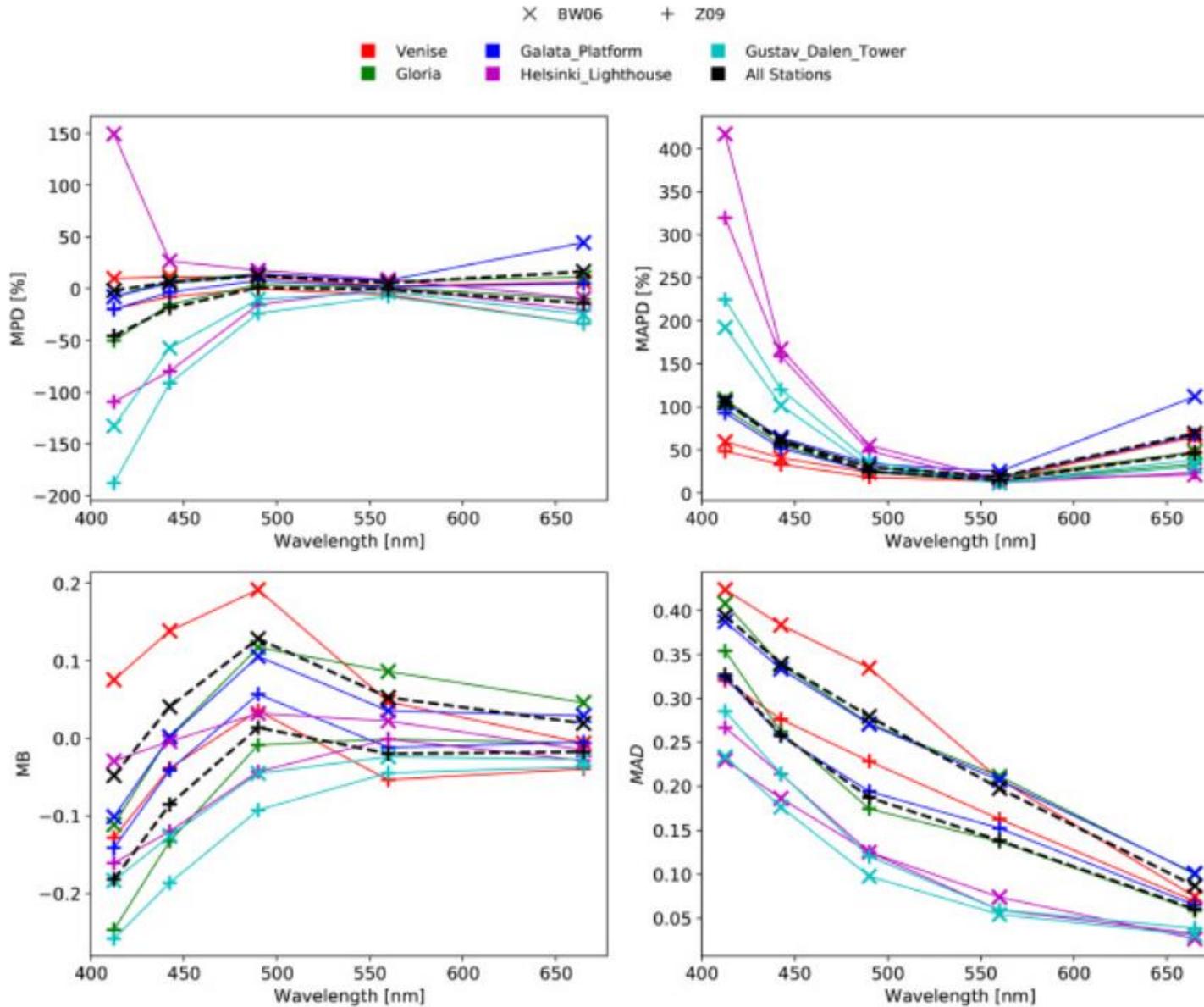
ThoMaS can be run with many other extraction protocols, that you define



Some background: match-ups: what protocol to use?

Should we care ab

YES



[Concha et al. 2021]

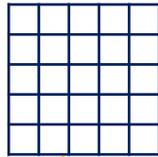
Current EUMETSATs matchup protocol

EUMETSATs Matchup Protocols: extraction of statistics at macropixel level

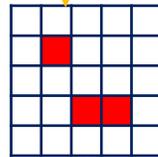
Window size recommended: **5x5** or **3x3**

Tolerable insitu-satellite time difference: **1 hr** or **3 hrs**

Set BFOR: 5x5 window



Detection of non-valid pixels (flagged pixels)



Pixels are masked/removed if flagged by any of the following:

CLOUD, CLOUD_AMBIGUOUS, CLOUD_MARGIN, INVALID, COSMETIC, SATURATED, SUSPECT, HISOLZEN, HIGHGLINT, SNOW_ICE, AC_FAIL, WHITECAPS, ADJAC, RWNEG_O2, RWNEG_O3, RWNEG_O4, RWNEG_O5, RWNEG_O6, RWNEG_O7, RWNEG_O8

Set BOR: without flagged pixels



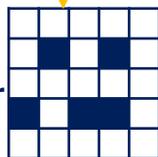
Macropixel is discarded if:

$$N_{BOR} < 50\% N_{BFOR}$$

Pixel X is considered outlier if:

$$|value@X - \mu_{BOR}| < 1.5\sigma_{BOR}$$

Set final: without flagged & outlier



Central value: median_{final}
 Uncertainty measure: σ_{final}
 Homogeneity measure: CV_{final}

Macropixel is discarded if:

$$CV_{final}(560) > 20\%$$

$\mu \rightarrow$ Mean
 $\sigma \rightarrow$ Standard deviation

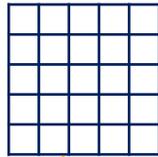
Current EUMETSATs matchup protocol: proposed changes (1)

EUMETSATs Matchup Protocols: extraction of statistics at macropixel level

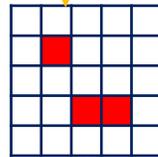
Window size recommended: **5x5** or **3x3**

Tolerable insitu-satellite time difference: **1 hr** or **3 hrs**

Set BFOR: 5x5 window



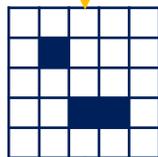
Detection of non-valid pixels (flagged pixels)



Pixels are masked/removed if flagged by any of the following:

CLOUD, CLOUD_AMBIGUOUS, CLOUD_MARGIN, INVALID, COSMETIC, SATURATED, SUSPECT, HISOLZEN, HIGHGLINT, SNOW_ICE, AC_FAIL, WHITECAPS, ADJAC, RWNEG_O2, RWNEG_O3, RWNEG_O4, RWNEG_O5, RWNEG_O6, RWNEG_O7, RWNEG_O8

Set BOR: without flagged pixels



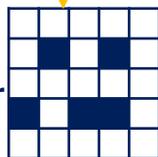
Macropixel is discarded if:

$$N_{BOR} < 50\% N_{BFOR}$$

Pixel X is considered outlier if:

$$|value@X - \mu_{BOR}median_{BOR}| < 1.5\sigma_{BOR} \frac{10}{9} IQR_{BOR}$$

Set final: without flagged & outlier



Central value: μ_{final}
 Uncertainty measure: σ_{final}
 Homogeneity measure: CV_{final}

Macropixel is discarded if:

$$CV_{final}(560) > 20\%$$

$\mu \rightarrow$ Mean
 $\sigma \rightarrow$ Standard deviation

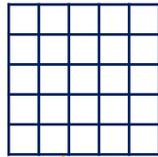
Current EUMETSATs matchup protocol: proposed changes (2)

EUMETSATs Matchup Protocols: extraction of statistics at macropixel level

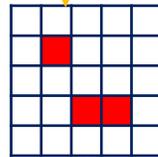
Window size recommended: **5x5** or **3x3**

Tolerable insitu-satellite time difference: **1 hr** or **3 hrs**

Set BFOR: 5x5 window



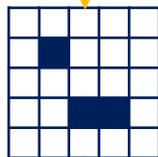
Detection of non-valid pixels (flagged pixels)



Pixels are masked/removed if flagged by any of the following:

CLOUD, CLOUD_AMBIGUOUS, CLOUD_MARGIN, INVALID, COSMETIC, SATURATED, SUSPECT, HISOLZEN, HIGHGLINT, SNOW_ICE, AC_FAIL, WHITECAPS, ADJAC, RWNEG_O2, RWNEG_O3, RWNEG_O4, RWNEG_O5, RWNEG_O6, RWNEG_O7, RWNEG_O8

Set BOR: without flagged pixels



Macropixel is discarded if:

$$N_{BOR} < 50\% N_{BFOR}$$

Pixel X is considered outlier if:

$$|value@X - \mu_{BOR}median_{BOR}| < 1.5\sigma_{BOR}0.86IQR_{BOR}$$

Set final: without flagged & outlier



Central value: μ_{final}
 Uncertainty measure: σ_{final}
 Homogeneity measure: CV_{final}

Macropixel is discarded if:

$$CV_{final}(560) > 20\%$$

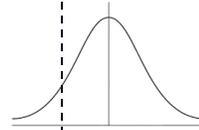
$\mu \rightarrow$ Mean
 $\sigma \rightarrow$ Standard deviation

- In situ data used: AERONET-OC, Level 2.0
- Stations: Casablanca_Platform, Gloria,Helsinki_Lighthouse, LISCO,Section-7_Platform, USC_SEAPRISM, Galata_Platform, Gustav_Dalen_Tower, Lake_Erie, Palgrunden, Socheongcho, Venice
- A total of 2139 matchups

Comparing outlier detection, pixel by pixel

Proposed "1"

Pixel X is considered outlier if:
 $|value@X - median| < \frac{10}{9} \times IQR$
 Central value = mean



NOT OUTLIER
 NOT OUTLIER
 OUTLIER

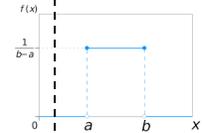
88.4%	3.27%
1.35%	7.02%

Current protocol

Pixel X is considered outlier if:
 $|value@X - mean| < 1.5 \times \sigma$
 Central value = median

Proposed "2"

Pixel X is considered outlier if:
 $|value@X - median| < \frac{\sqrt{3}}{2} \times IQR$
 Central value = mean



NOT OUTLIER
 NOT OUTLIER
 OUTLIER

83.5%	8.06%
2.32%	8.14%

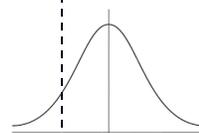
Current protocol

Pixel X is considered outlier if:
 $|value@X - mean| < 1.5 \times \sigma$
 Central value = median

Comparing screened macropixels

Proposed "1"

Pixel X is considered outlier if:
 $|value@X - median| < \frac{10}{9} \times IQR$
 Central value = mean



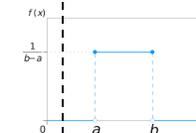
Current protocol

Pixel X is considered outlier if:
 $|value@X - mean| < 1.5 \times \sigma$
 Central value = median

	PASS	FAIL
PASS	1359	9
FAIL	3	768

Proposed "2"

Pixel X is considered outlier if:
 $|value@X - median| < \frac{\sqrt{3}}{2} \times IQR$
 Central value = mean



Current protocol

Pixel X is considered outlier if:
 $|value@X - mean| < 1.5 \times \sigma$
 Central value = median

	PASS	FAIL
PASS	1367	1
FAIL	9	762

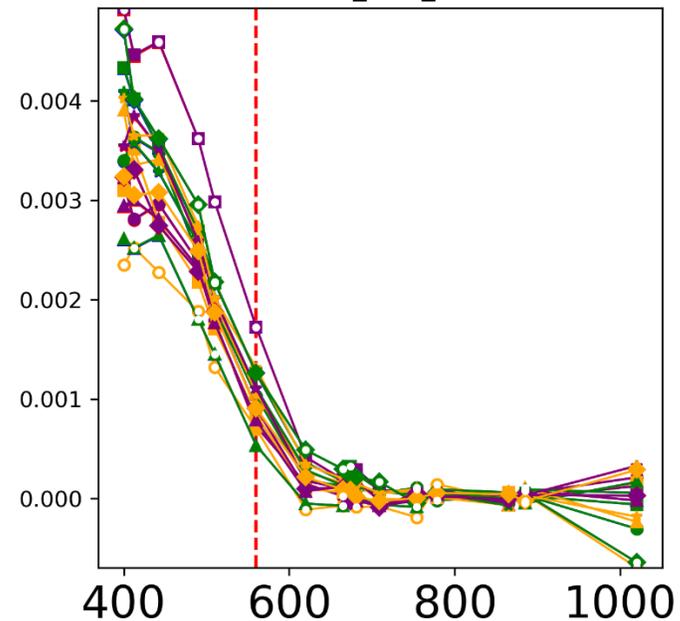
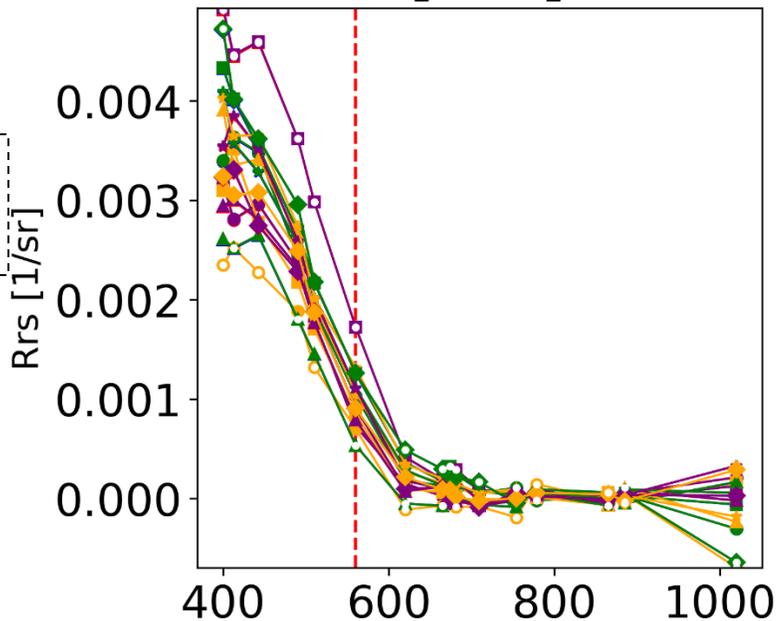
Casablanca_Platform_2021_03_09_09_46_11
EUMETSAT_standard_L2 (PASS)

Casablanca_Platform_2021_03_09_09_46_11
EUMETSAT_new_L2 (FAIL)

Current protocol

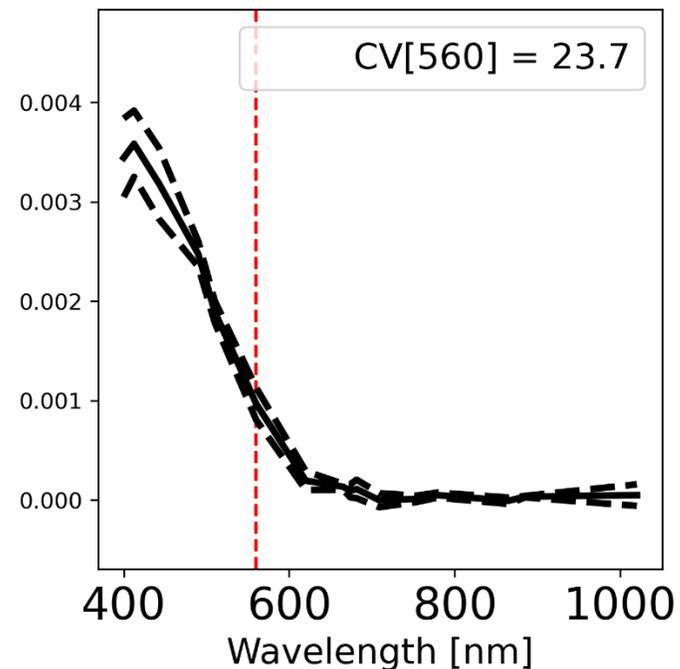
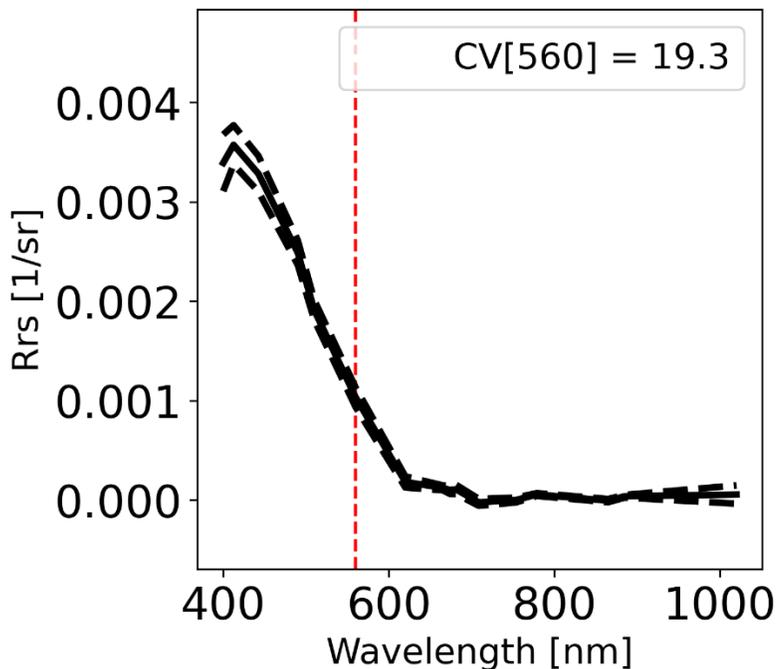
Pixel X is considered outlier if:
 $|value@X - mean| < 1.5 \times \sigma$
 Central value = median

- **White inner circles:** outliers
- **Black inner circles:** flags



Proposed "1"

Pixel X is considered outlier if:
 $|value@X - median| < \frac{10}{9} \times IQR$
 Central value = mean



Section-7_Platform_2019_09_12_08_05_52
EUMETSAT_standard_L2 (FAIL)

Section-7_Platform_2019_09_12_08_05_52
EUMETSAT_new_L2 (PASS)

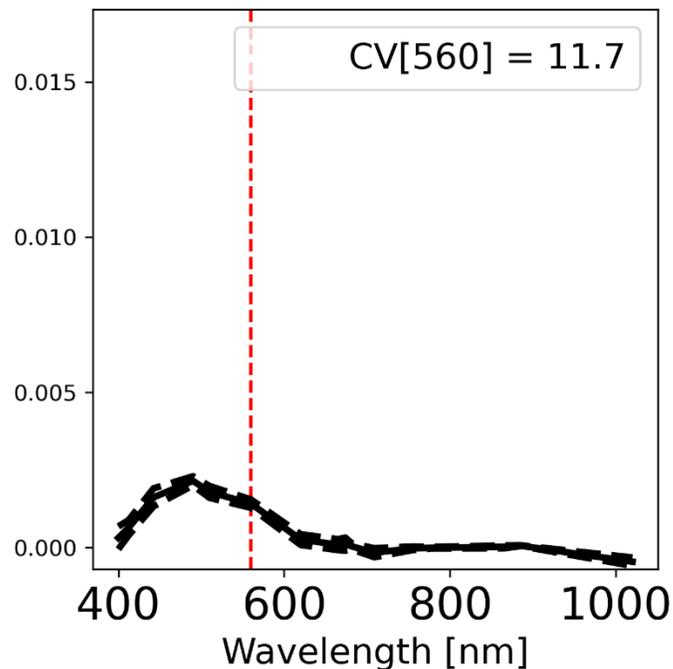
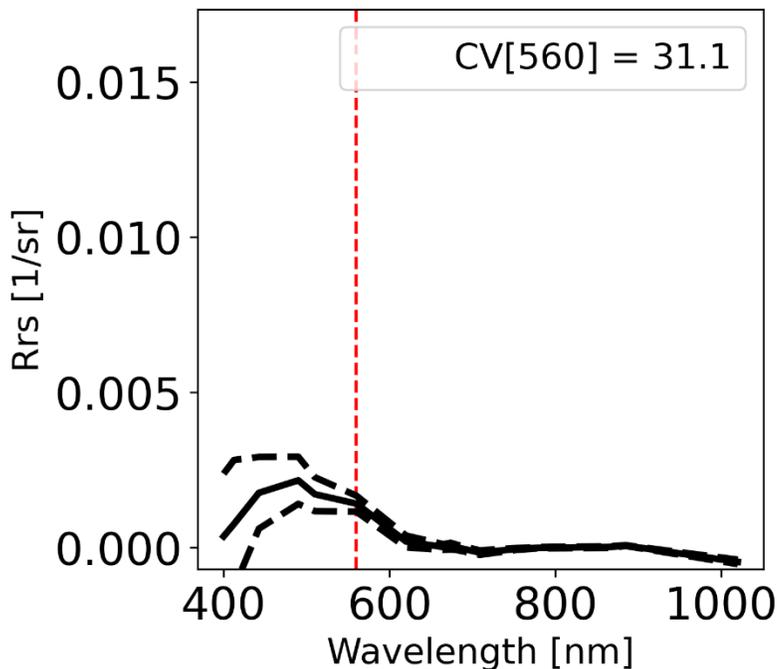
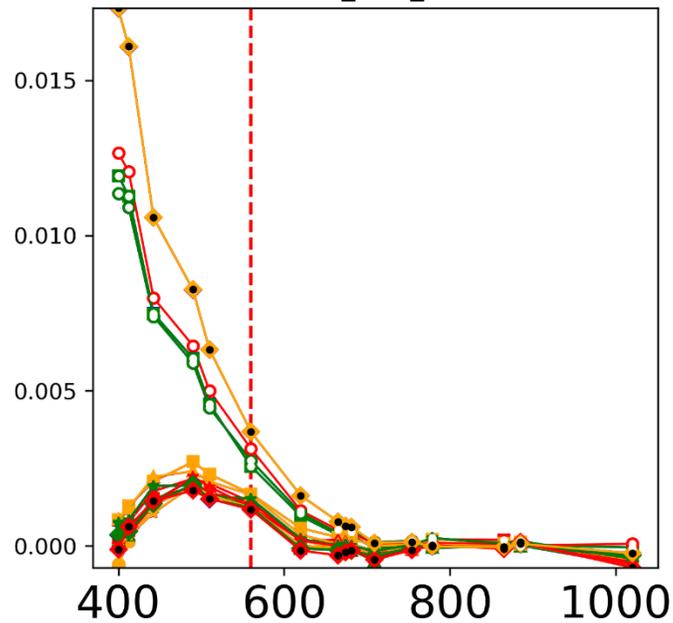
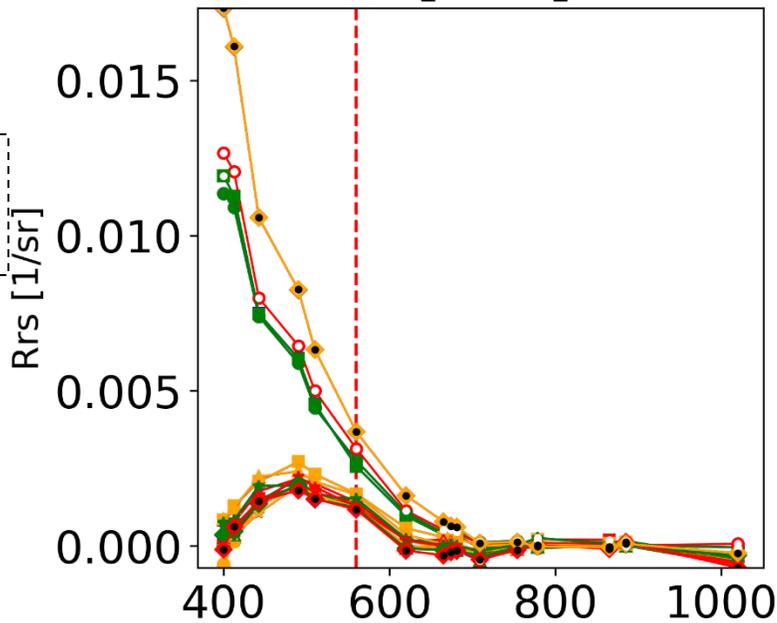
Current protocol

Pixel X is considered outlier if:
|value@X - mean| < $1.5 \times \sigma$
Central value = median

Proposed "1"

Pixel X is considered outlier if:
|value@X - median| < $\frac{10}{9} \times IQR$
Central value = mean

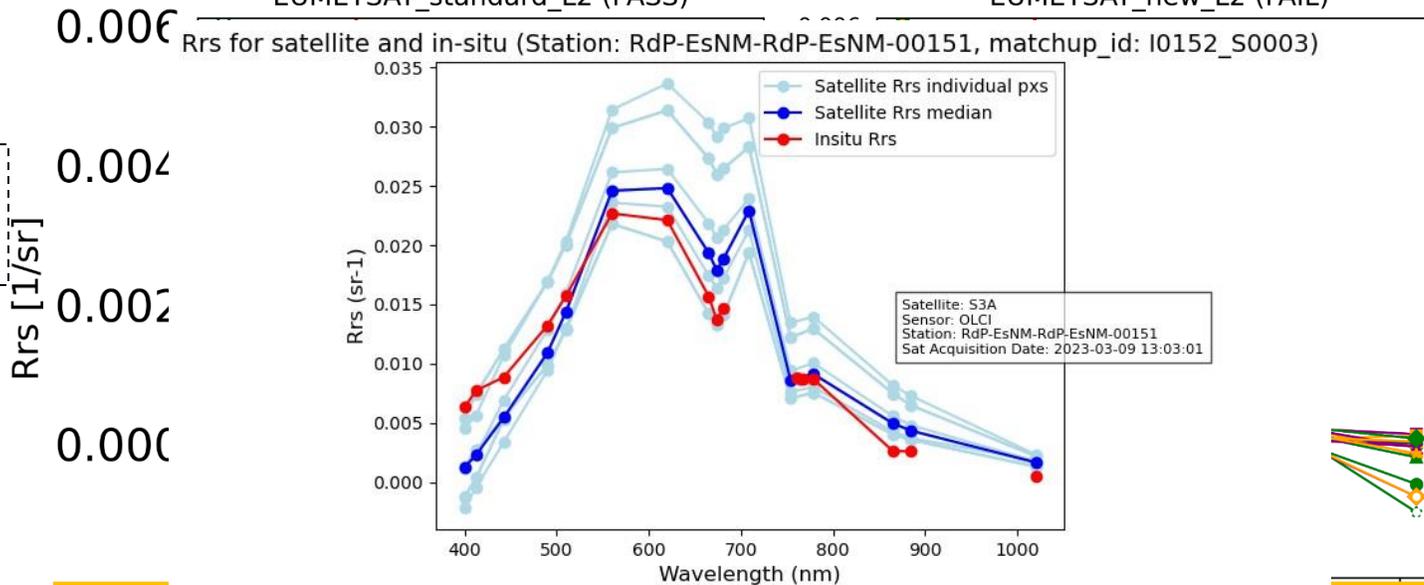
- **White inner circles:** outliers
- **Black inner circles:** flags



Current protocol

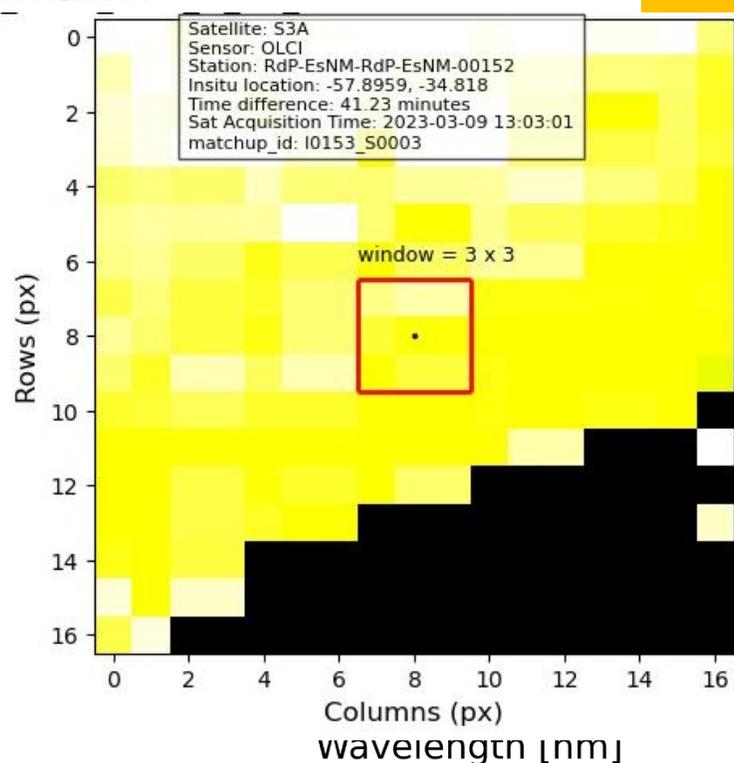
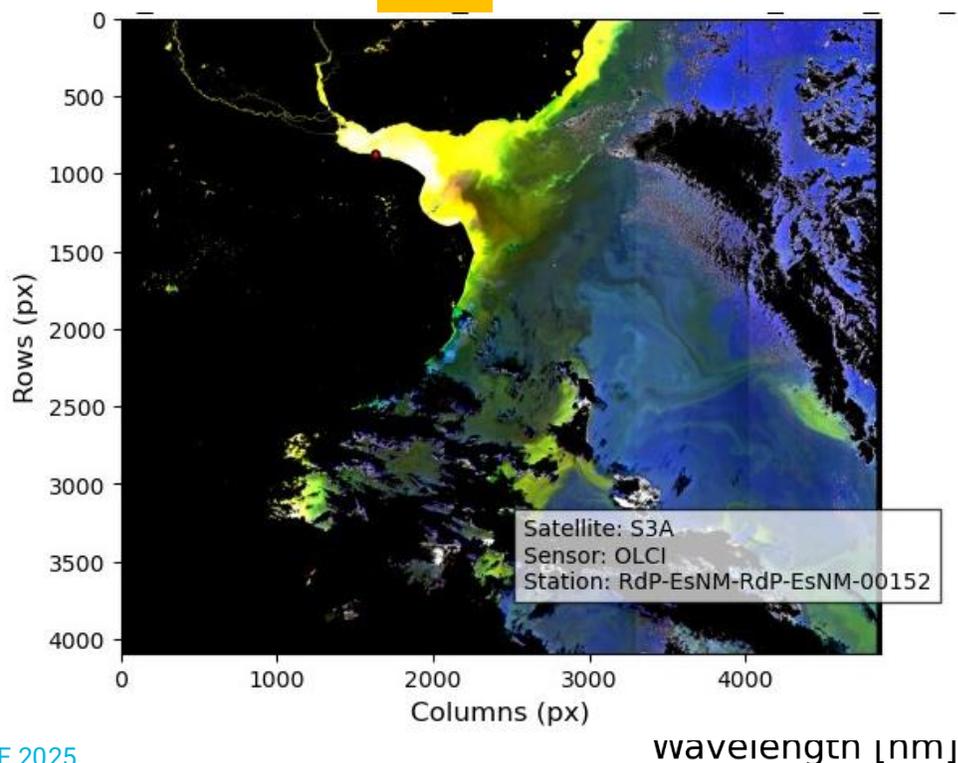
Pixel X is considered outlier if:
 $|value@X - mean| < 1.5 \times \sigma$
 Central value = median

- **White inner circles:** outliers
- **Black inner circles:** flags



Proposed "1"

Pixel X is considered outlier if:
 $|value@X - median| < \frac{10}{9} \times IQR$
 Central value = mean

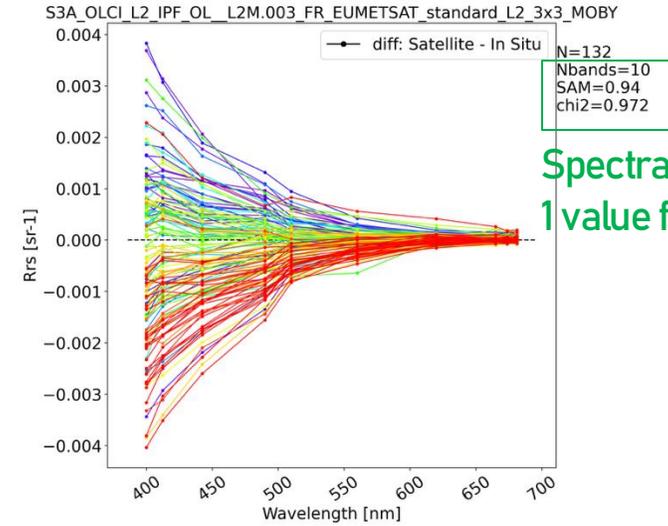
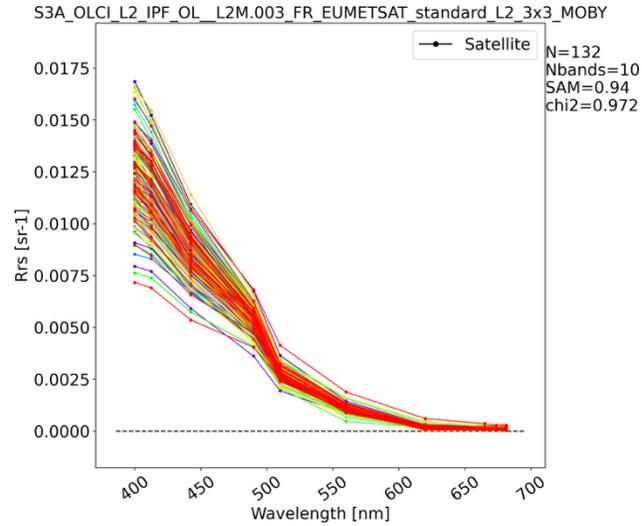
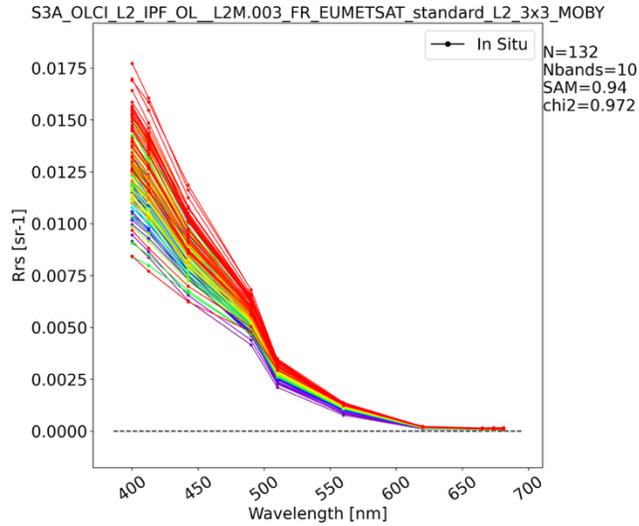


icular cases



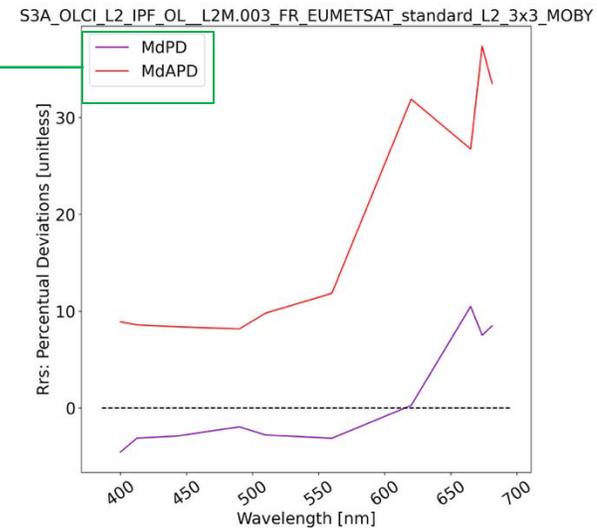
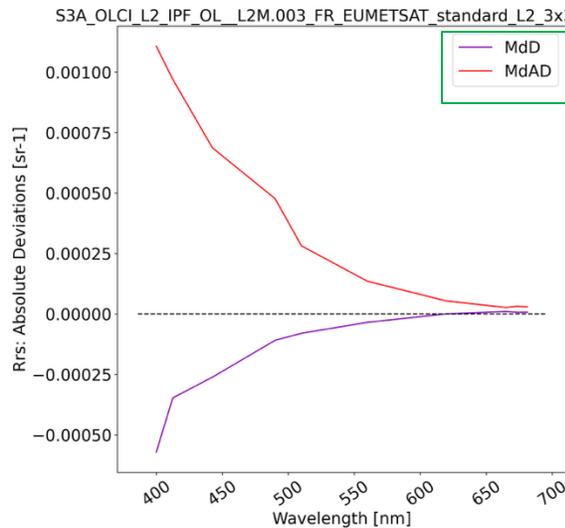
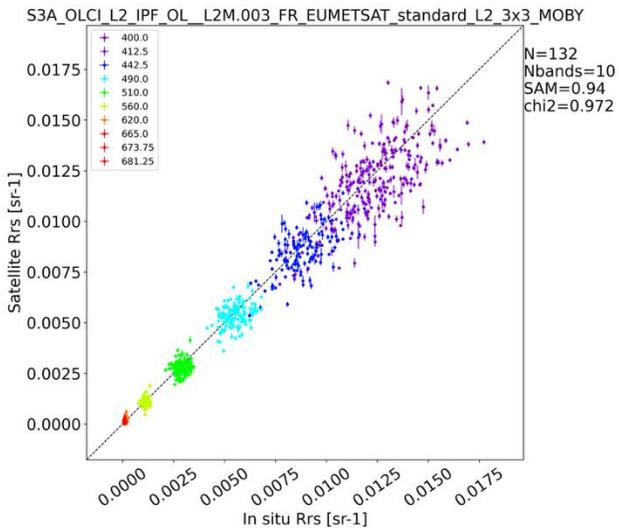
Some background: match-ups

Band-by-band plots and statistics are often not sufficient...



Spectral statistics
1 value for the whole set

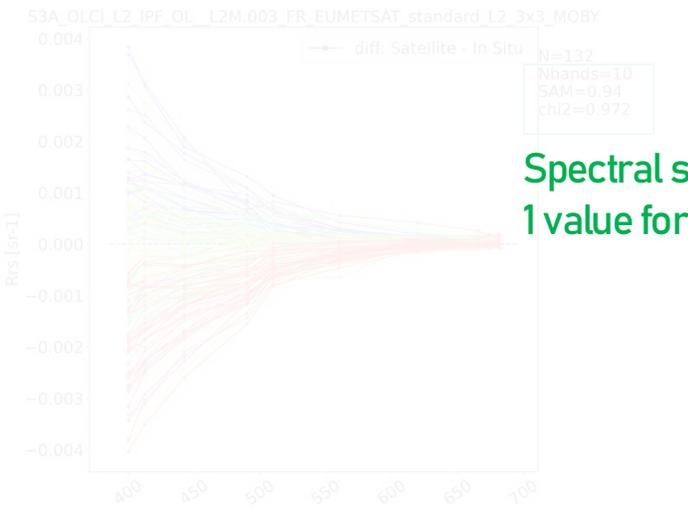
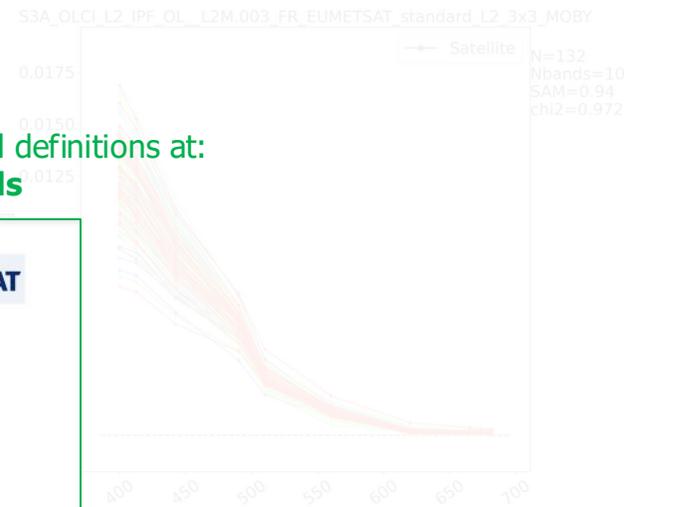
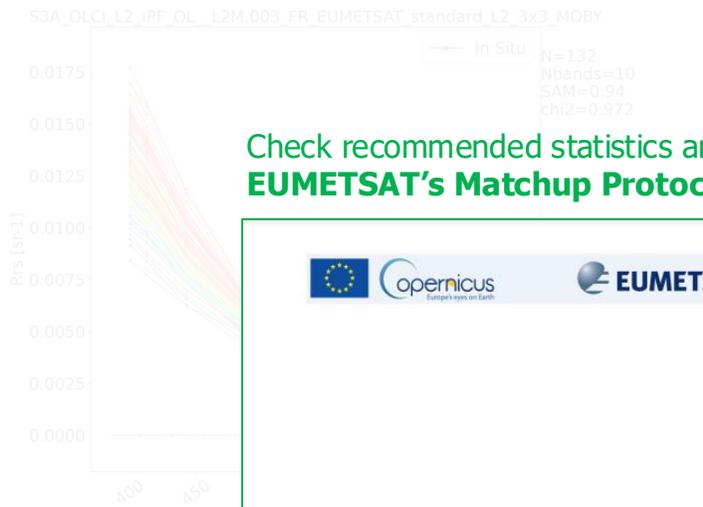
statistics band-by-band, plotted spectrally





Some background: match-ups

Band-by-band plots and statistics are often not sufficient...



Check recommended statistics and definitions at:
EUMETSAT's Matchup Protocols

Spectral statistics
1 value for the whole set

Recommendations for Sentinel-3 OLCI Ocean Colour product validations in comparison with in situ measurements - Matchup Protocols

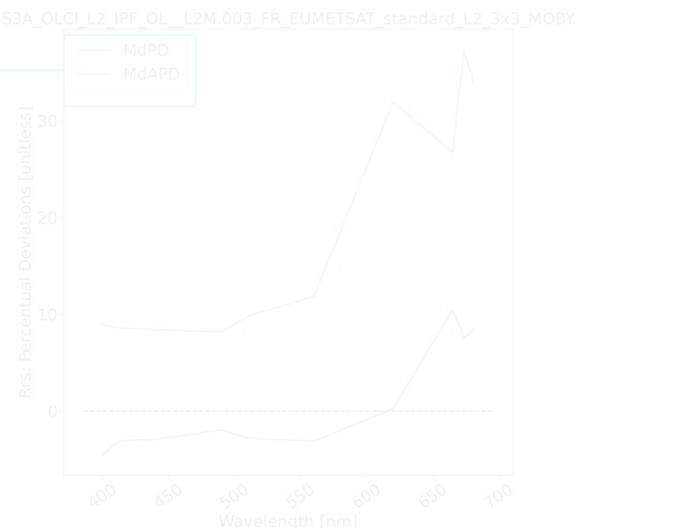
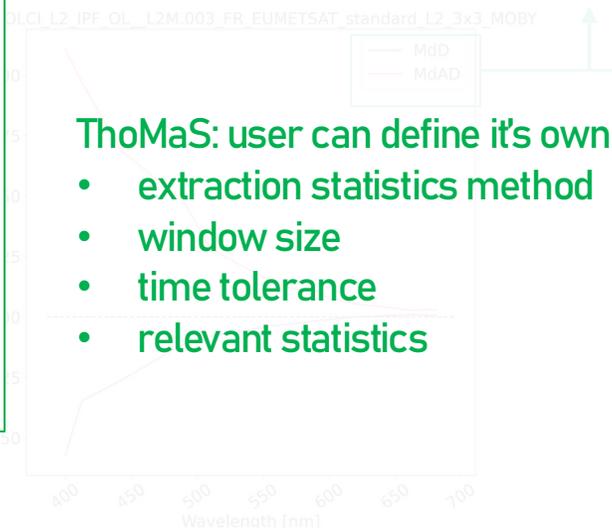
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Doc.No. : EUM/SENS/DOC/19/1092968
Issue : v7
Date : 17 May 2021
WBS/OBS :

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http://www.eumetsat.int

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statistics band-by-band, plotted spectrally



- ThoMaS: user can define its own
- extraction statistics method
 - window size
 - time tolerance
 - relevant statistics

Mean Difference →

$$\frac{1}{n} \sum_{i=1}^n \{Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}\}$$

Mean Percent Difference →

$$\frac{1}{n} \sum_{i=1}^n \left\{ \frac{Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}}{Rrs(\lambda)_{in\ situ,i}} \right\}$$

Mean Absolute Difference →

$$\frac{1}{n} \sum_{i=1}^n \{|Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}|\}$$

Mean Absolute Percent Difference →

$$\frac{1}{n} \sum_{i=1}^n \left\{ \left| \frac{Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}}{Rrs(\lambda)_{in\ situ,i}} \right| \right\}$$

Log-based Mean Absolute Difference → $LogMAD_{\lambda} = 10^{\sum_{i=1}^N |\log_{10}(Rrs(\lambda)_{OLCI,i}) - \log_{10}(Rrs(\lambda)_{in\ situ,i})|}$

Median Difference →

$$\text{median}_{1 \leq i \leq N} \{ Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i} \}$$

Median Percent Difference →

$$\text{median}_{1 \leq i \leq N} \left\{ \frac{Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}}{Rrs(\lambda)_{in\ situ,i}} \right\}$$

Median Absolute Difference →

$$\text{median}_{1 \leq i \leq N} \{ |Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}| \}$$

Median Absolute Percent Difference →

$$\text{median}_{1 \leq i \leq N} \left\{ \left| \frac{Rrs(\lambda)_{OLCI,i} - Rrs(\lambda)_{in\ situ,i}}{Rrs(\lambda)_{in\ situ,i}} \right| \right\}$$

Spectral Angle Mapper →

$$SAM = \frac{1}{N} \sum_{i=1}^N \left(\arccos \left(\frac{\langle Rrs_{in\ situ,i}, Rrs_{OLCI,i} \rangle}{\|Rrs_{in\ situ,i}\| \|Rrs_{OLCI,i}\|} \right) \right)$$

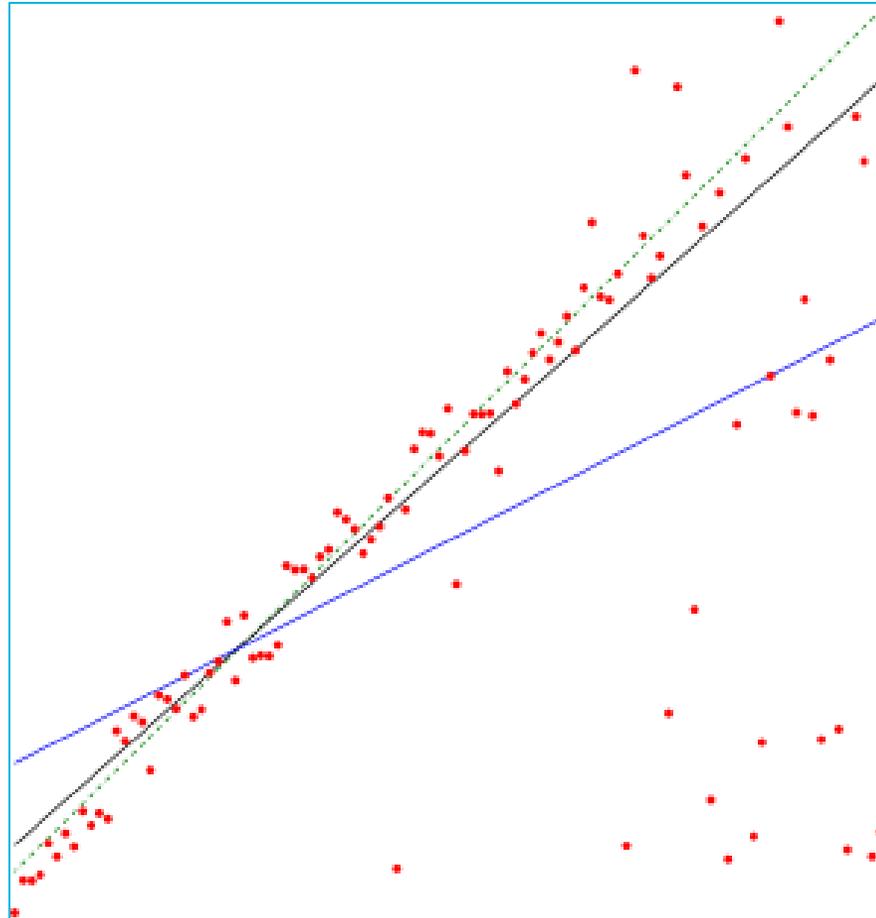
Chi-squared →

$$\chi^2 = \frac{1}{N} \sum_{i=1}^N \left(\sum_{\lambda} \frac{(Y(\lambda)_{in\ situ,i} - Y(\lambda)_{OLCI,i})^2}{Y(\lambda)_{in\ situ,i}} \right)$$

$$Y(\lambda)_i = \frac{Rrs(\lambda)_i}{Rrs(560)_i}$$

+ linear regression of two types...

+ linear regression of two types...



--- Standard Least-Squares

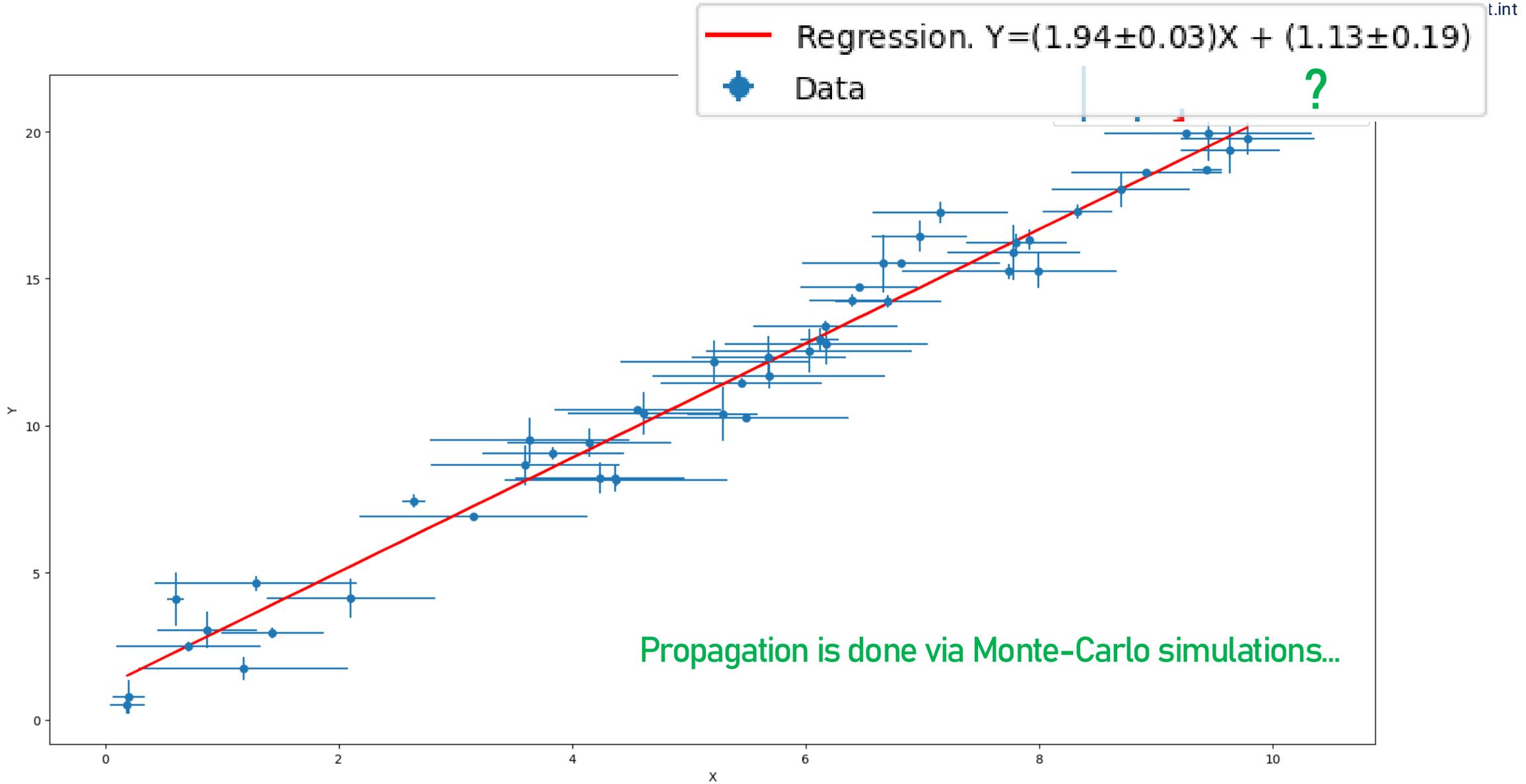
---Theil-Sen regressor

- 1:1 line

There is no one better than the other. Having both to compare can give a first assessment of the effect of the outliers in your matchup performances



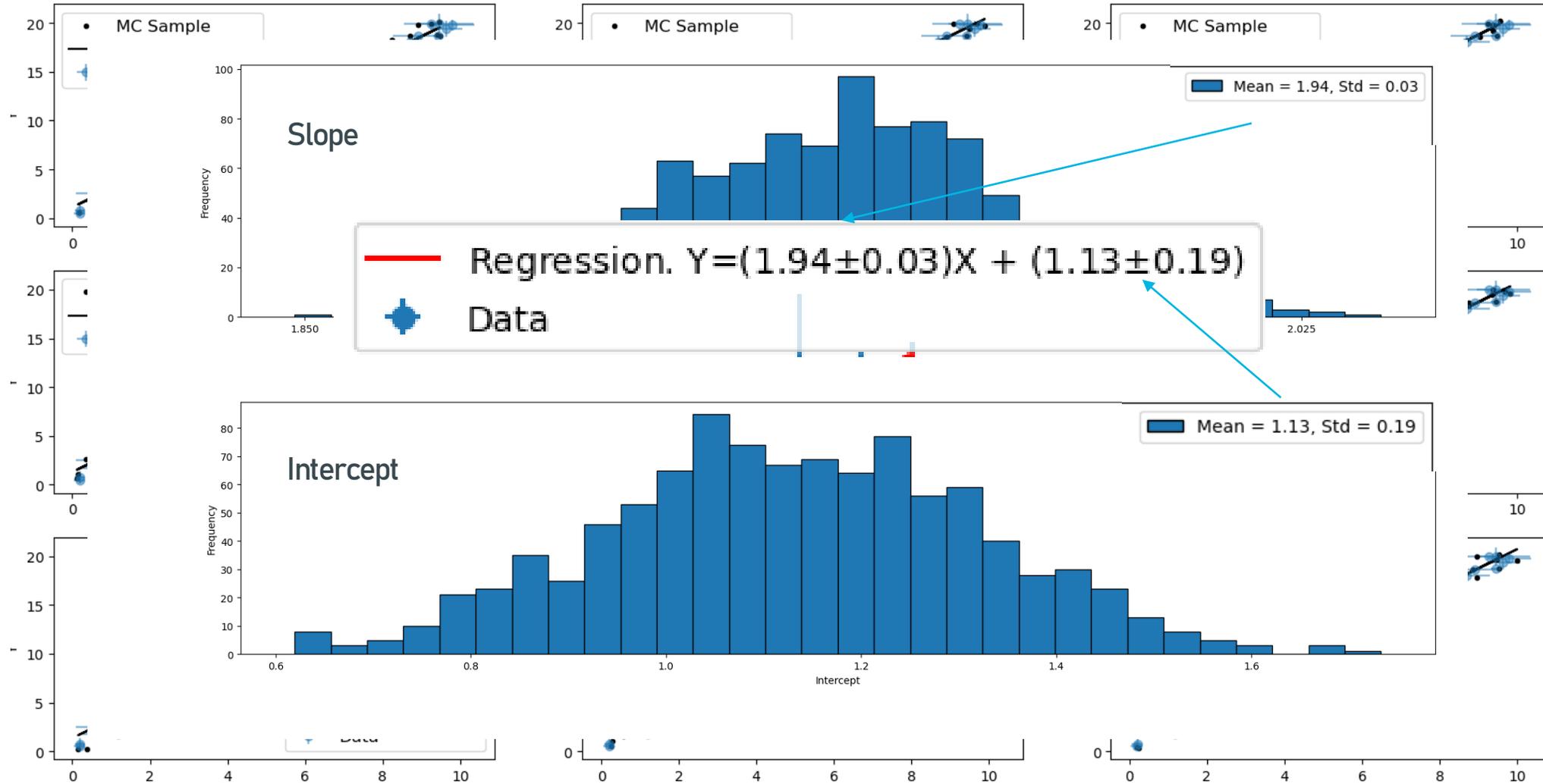
Some background: Performance metrics: unc. propagation





Some background: Performance metrics: unc. propagation

1000 random re-samplings of the type $N(x, u_x)$



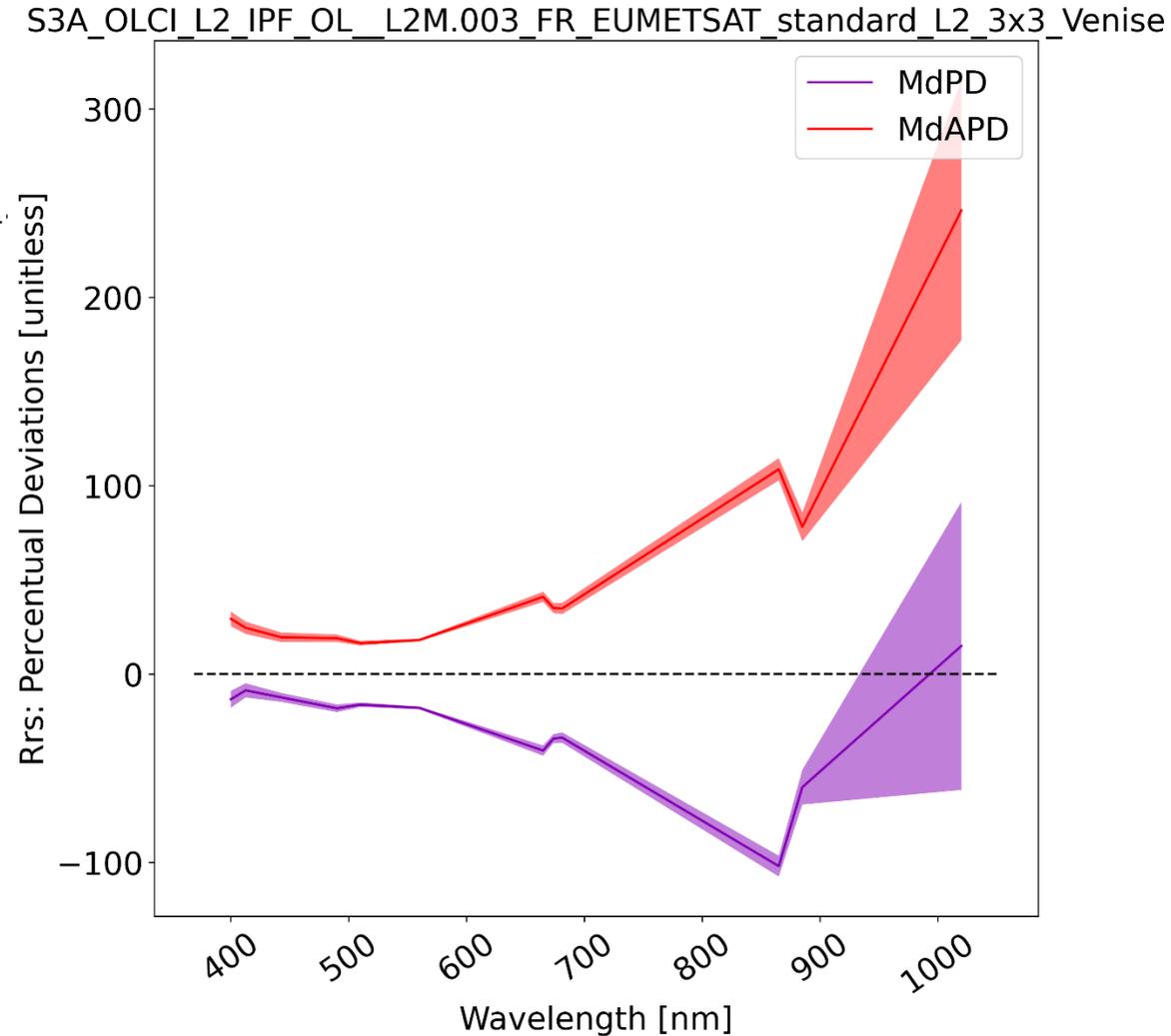
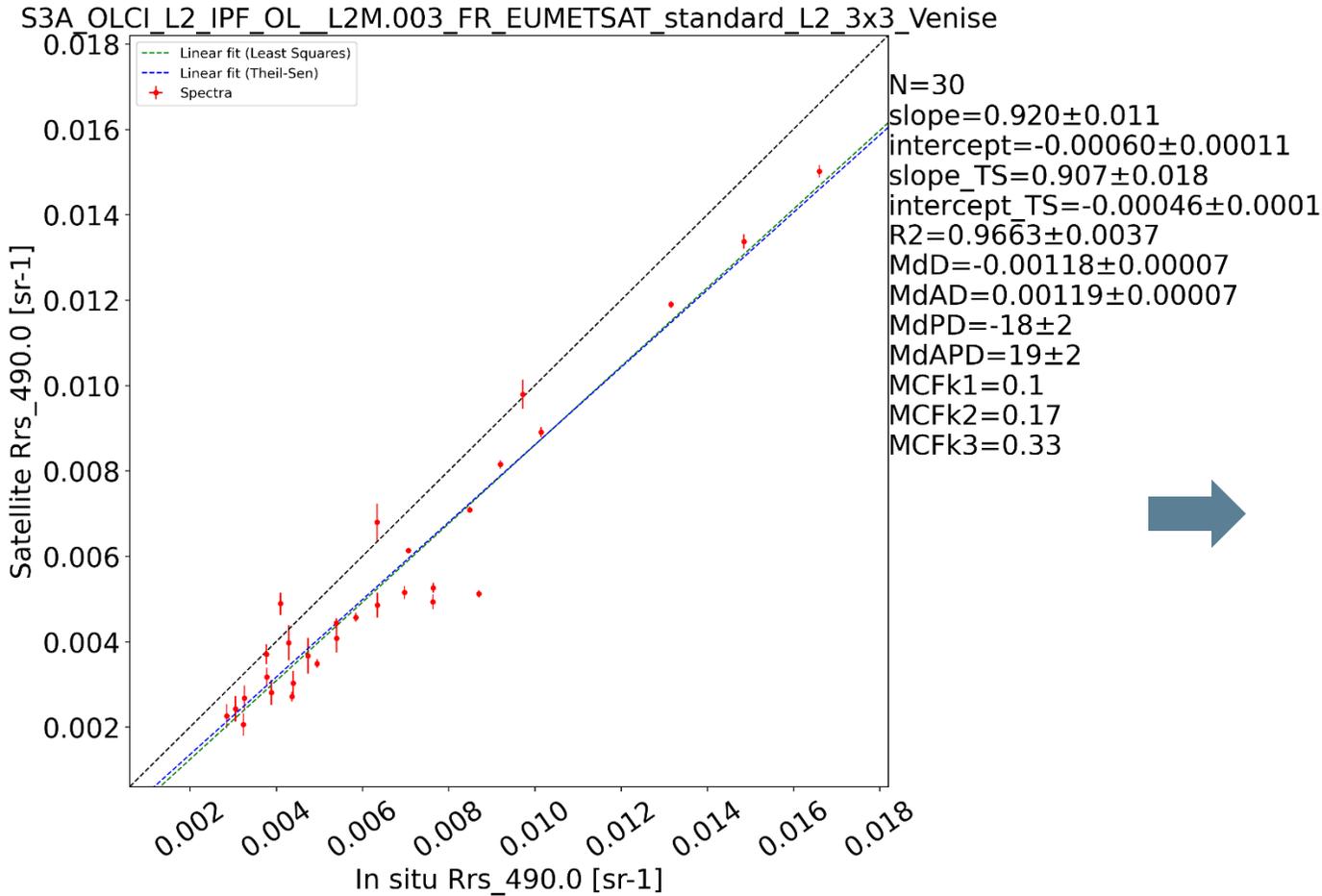


Some background: Performance metrics: unc. propagation

Uncertainties in satellite/insitu component ...



... propagated to performance metrics

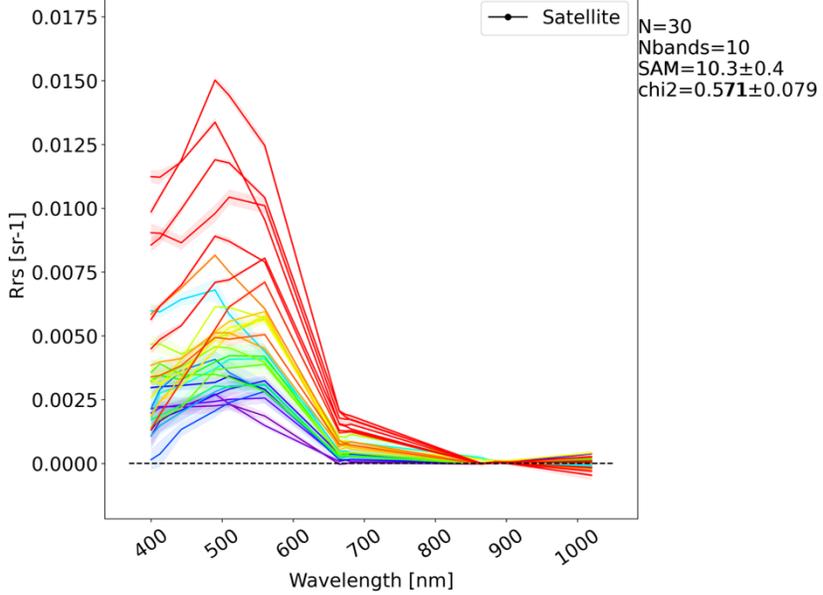




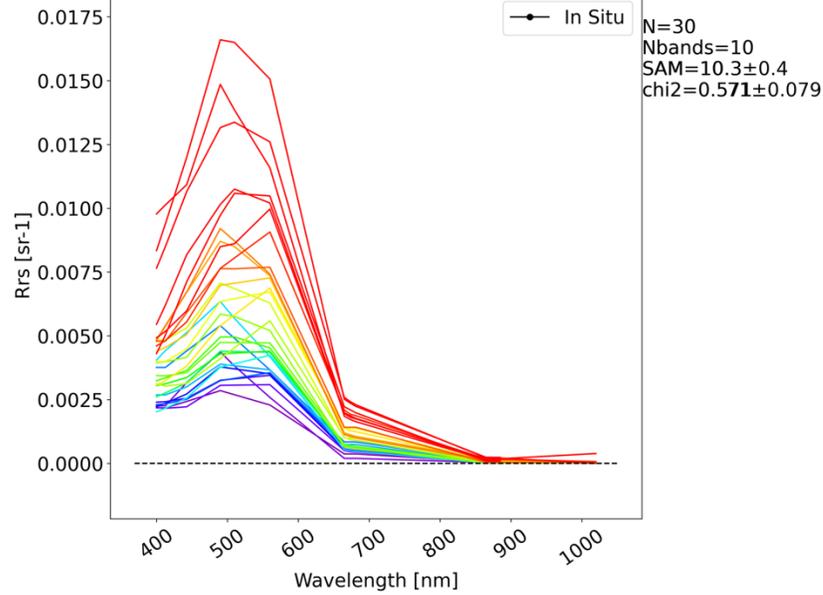
Some background: Performance metrics: unc. propagation

copernicus.eumetsat.int

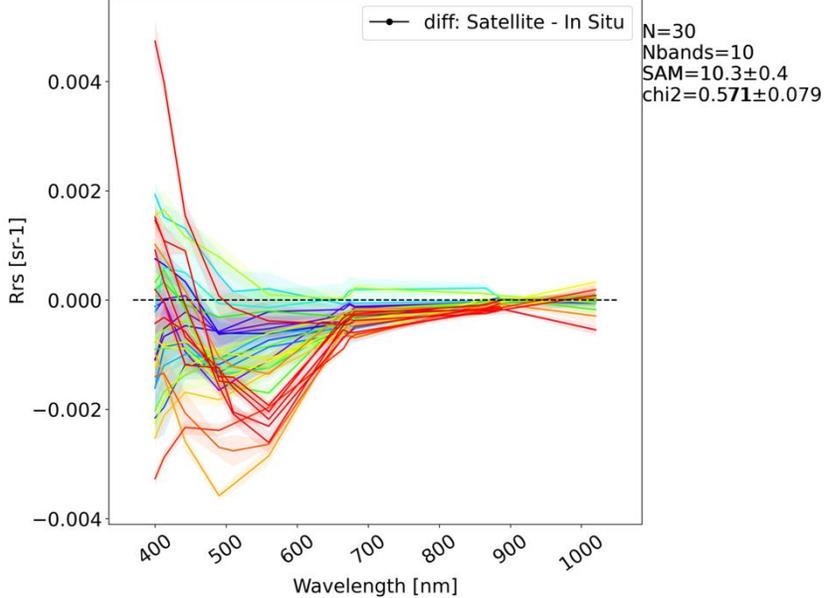
S3A_OLCI_L2_IPF_OL_L2M.003_FR_EUMETSAT_standard_L2_3x3_Venise



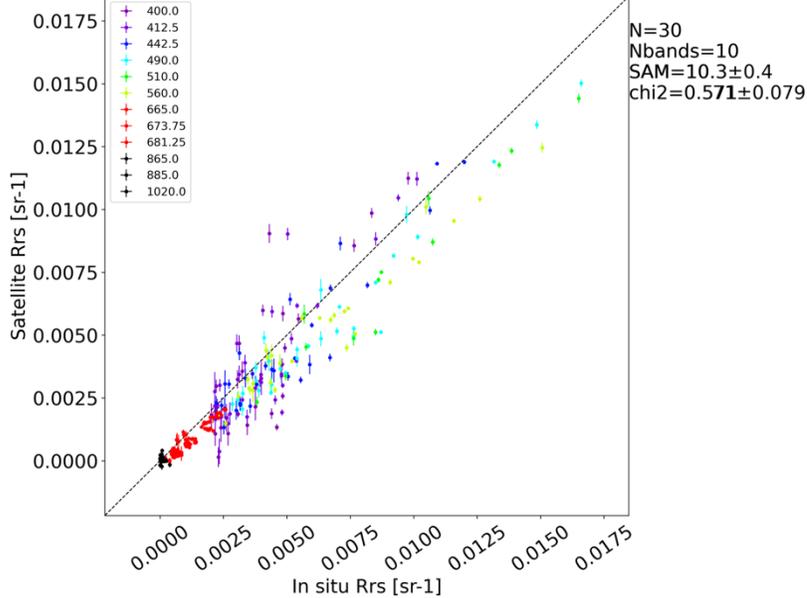
S3A_OLCI_L2_IPF_OL_L2M.003_FR_EUMETSAT_standard_L2_3x3_Venise

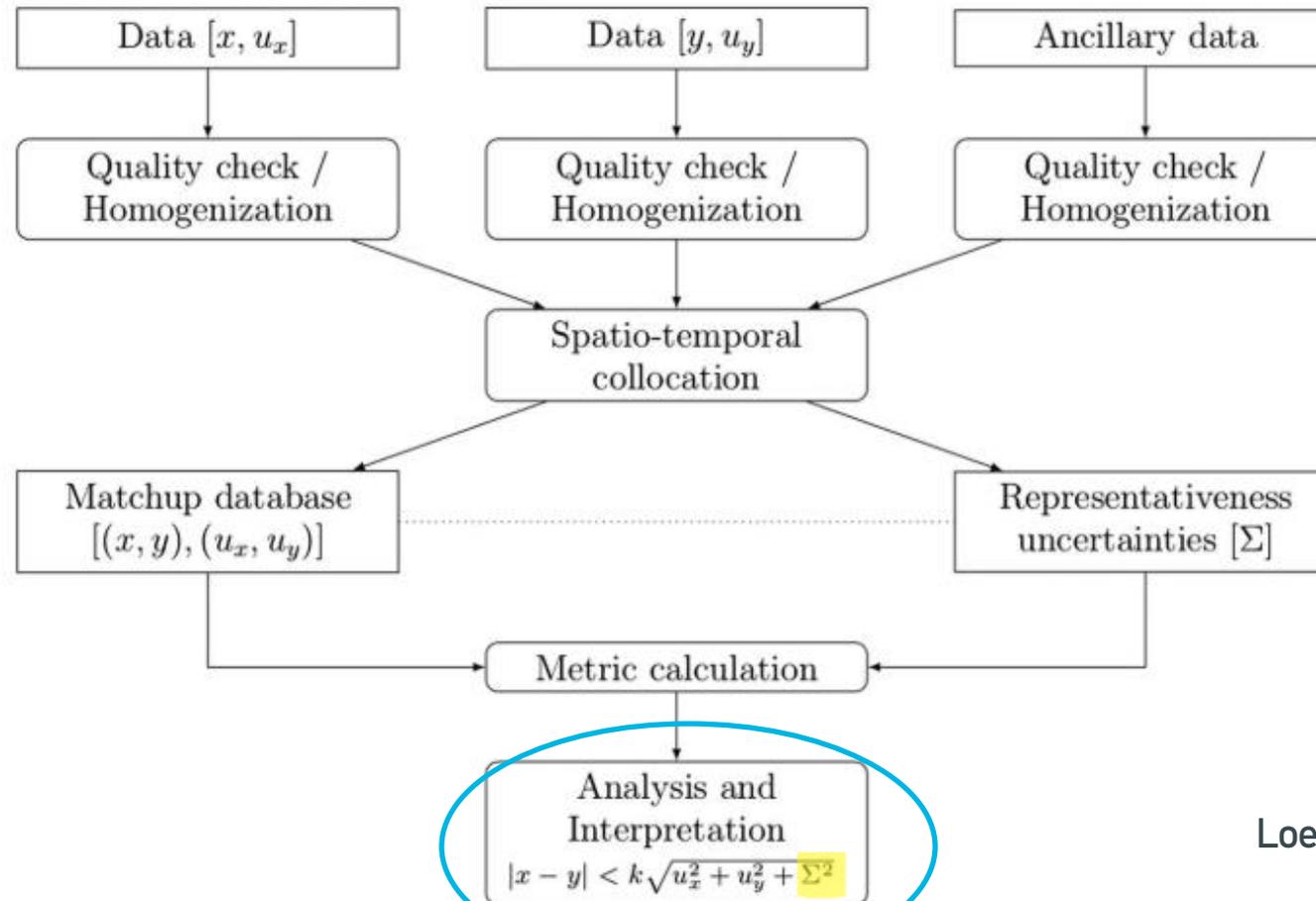


S3A_OLCI_L2_IPF_OL_L2M.003_FR_EUMETSAT_standard_L2_3x3_Venise



S3A_OLCI_L2_IPF_OL_L2M.003_FR_EUMETSAT_standard_L2_3x3_Venise





Loew et al 2017

Difference between measurements fall within uncertainties?

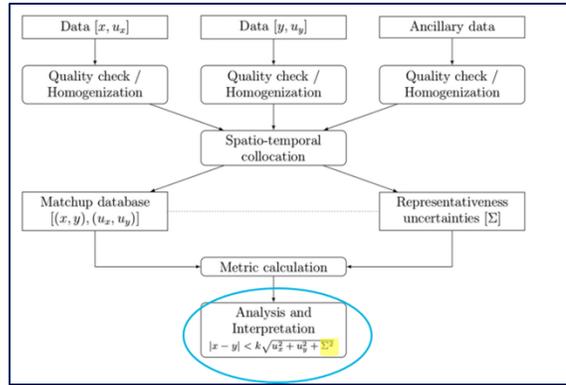
k = coverage factor



Some background: Metrologically-Compatible Fraction

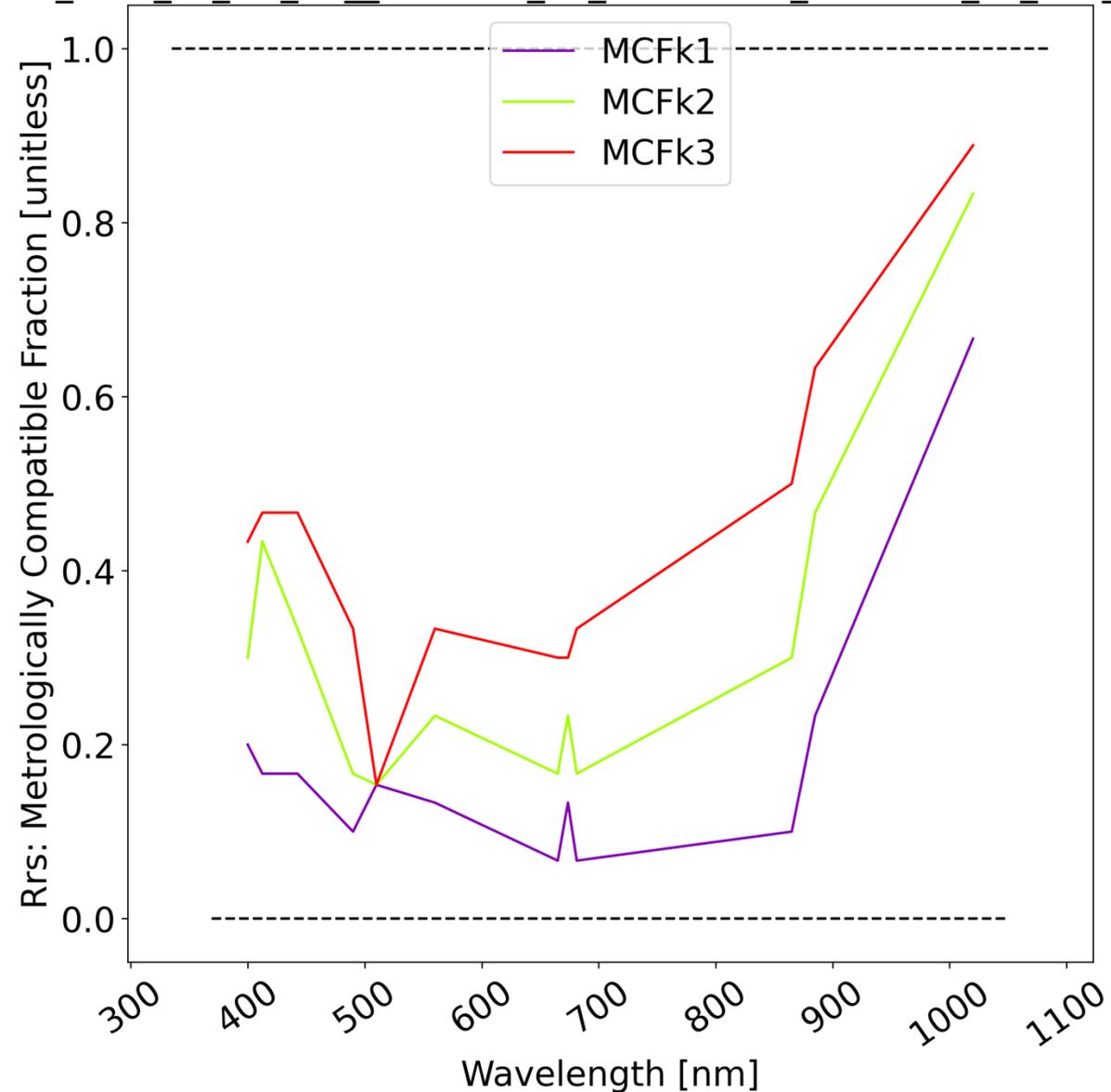
copernicus.eumetsat.int

S3A_OLCI_L2_IPF_OL_L2M.003_FR_EUMETSAT_standard_L2_3x3_Venise



$$MCF(k) = \frac{\#\{|x - y| < k(u_x + u_y)\}}{N}$$

Metrologically-Compatible Fraction
 → Recommended by Kevin Ruddick



Area of a radar plot, the definite statistics?

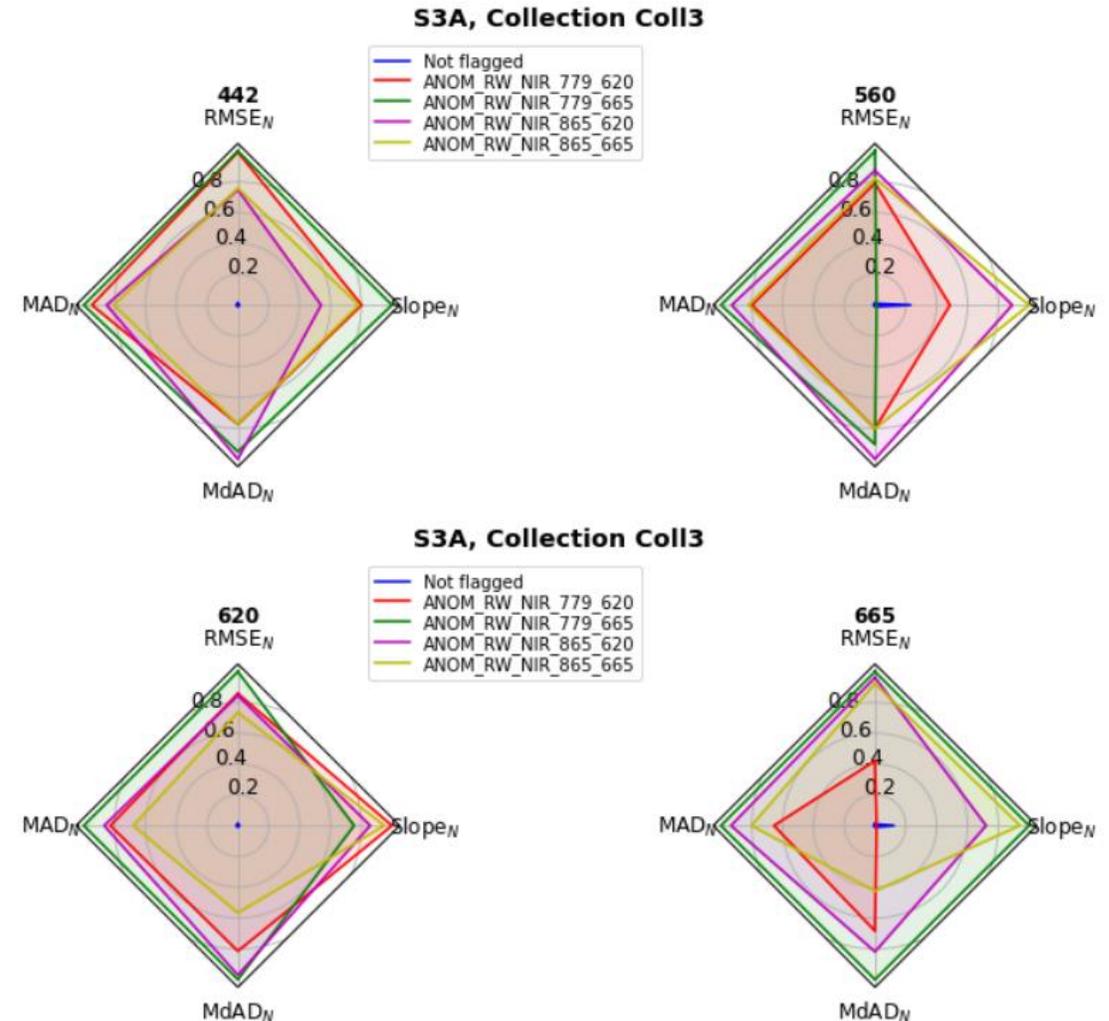
All performance metrics are mathematical calculations entirely based on your data.

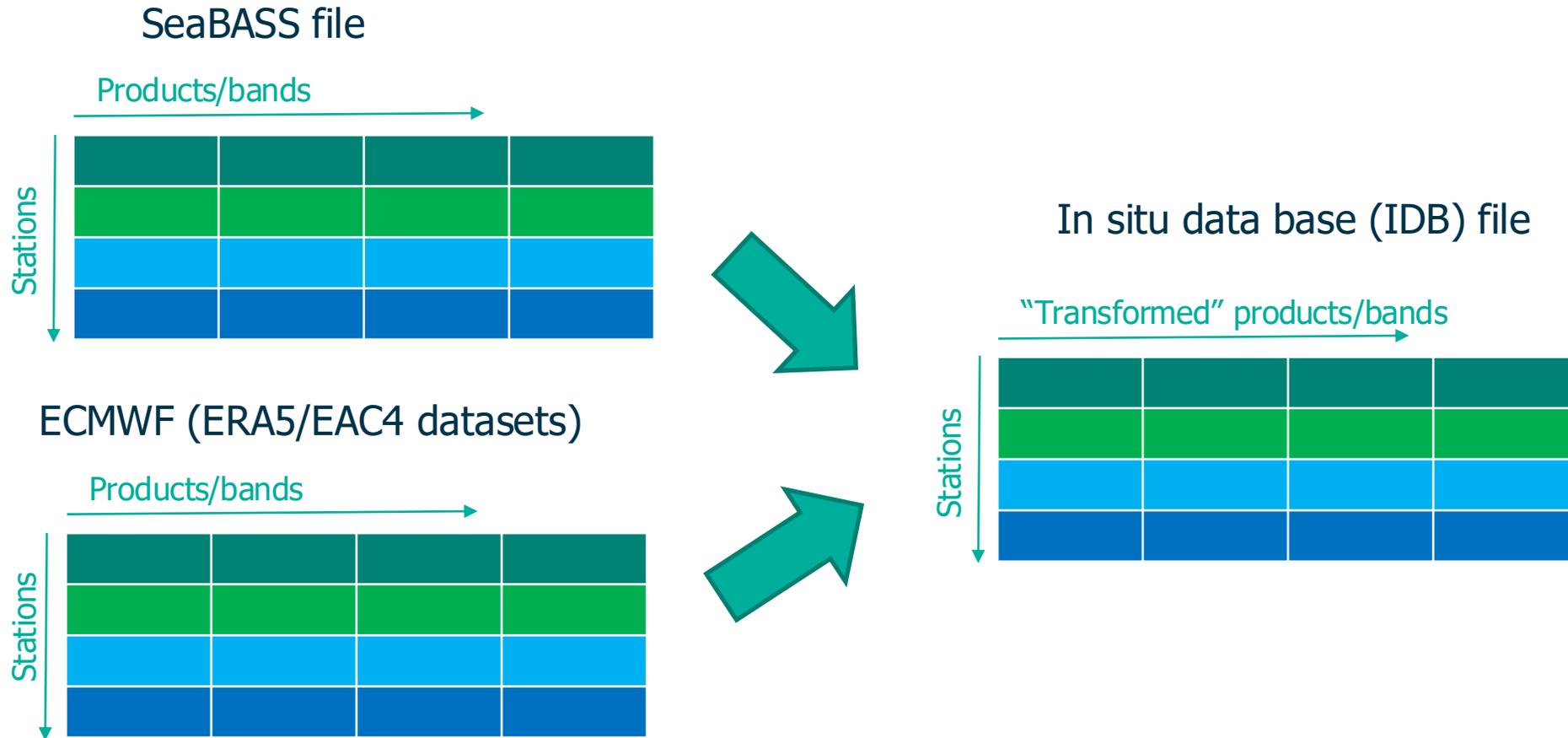
But they have a concrete meaning.

The area inside the radar plot is ambiguous in two senses:

- It depends on the (typically random) way in which you normalize the axes.
- It depends on the (typically random) choice of statistics that represent each vertex

In the end, it's just a soup of sums and subtractions of other performance metrics that have a specific justification for being defined as they are..





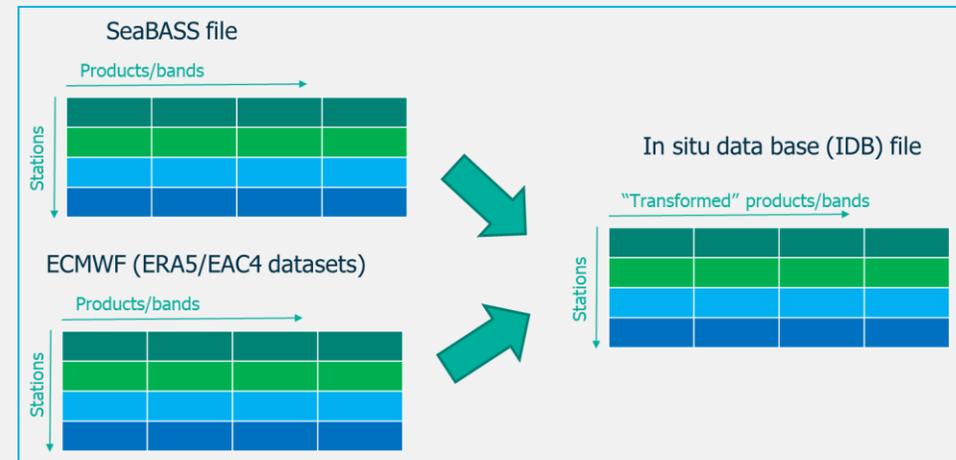


Usage. Step insitu: SeaBASS/OCDB file

```

/begin_header
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/affiliations=TestAffiliation
/contact=TestContact@TestInstitution.org
/received=20190101
/processed=20190101
/experiment=TestExperiment
/cruise=TestCruise
/station=NA
/data_file_name=TestOCDBsubmission.txt
/documents=see_comments
/calibration_files=see_comments
/data_type=cast
/data_status=final
/water_depth=NA
/BRDF_correction=None
/instrument_model=RAMSES
/instrument_manufacturer=TriOS
/calibration_date=NA
!
! COMMENTS
!
! Citation: Cite your paper where your data are published
!
/missing=-9999.
/delimiter=comma
/fields=station,date,time,lon,lat,depth,cloud,RelAz,AOT,spm,Chla,Rrs355,Rrs360,Rrs365,Rrs370,Rrs375,Rrs380,Rrs385,Rrs390,Rrs395,Rrs400,Rrs405,Rrs410,...
/units=none,yyymmdd, hh:mm:ss,degrees,degrees,m,%,degrees,unitless,mg/L,mg/m^3,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,...
/end_header
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TestStation002,20201014,11:55:00,-32.6232,32.0859,0.01,0,134.8,0.2388,0.1,0.1,0.002158972,0.002363762,0.00247761,0.00264967,0.002880799,0.003116844,0.0034196,...
TestStation003,20201014,12:16:00,-32.0209,26.9584,0.01,0,134.7,0.2388,0.1,0.1,0.001918189,0.002097384,0.002191946,0.002353893,0.002567901,0.002792078,0.00307,...
TestStation004,20210910,09:40:00,3,-3,0.01,0,134.9,0.2388,0.1,0.1,0.001271305,0.001359205,0.00139314,0.001432681,0.001487187,0.00153414,0.00160502,0.00165816,...
TestStation005,20210910,09:54:00,-4,4,0.01,0,134.8,0.277,0.1,0.1,0.00123858,0.001313013,0.001336158,0.00136599,0.001412448,0.001450581,0.001508596,0.00155277,...
TestStation006,20210910,10:07:00,5,-5,0.01,0,134.8,0.277,0.1,0.1,0.001126482,0.001192422,0.001211226,0.001237373,0.001276362,0.001307301,0.00135953,0.0013975,...

```





Usage. Step insitu: SeaBASS/OCDB file

```

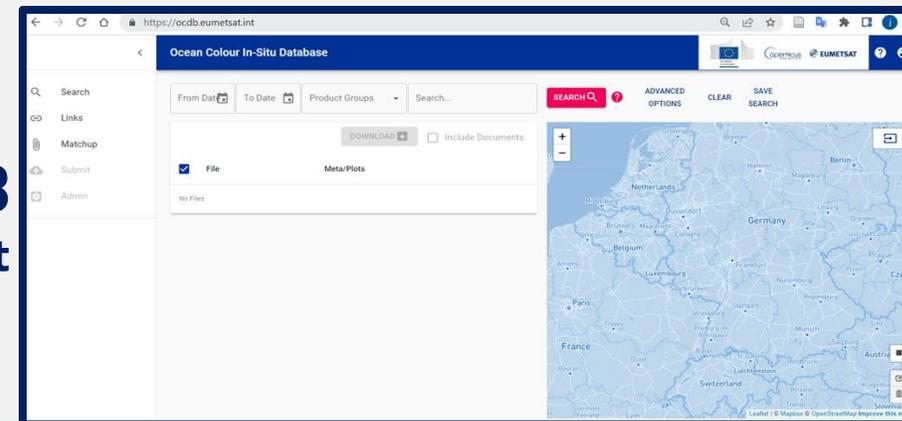
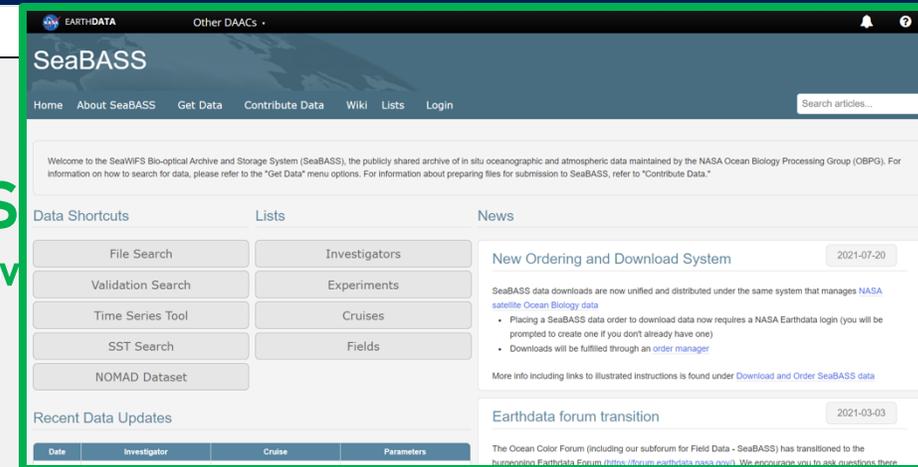
/begin_header
/investigators=TestPI
/affiliations=TestAffiliation
/contact=TestContact@TestInstitution.org
/received=20190101
/processed=20190101
/experiment=TestExperiment
/cruise=TestCruise
/station=NA
/data_file_name=TestOCDBsubmission.txt
/documents=see_comments
/calibration_files=see_comments
/data_type=cast
/data_status=final
/water_depth=NA
/BRDF_correction=None
/instrument_model=RAMSES
/instrument_manufacturer=TriOS
/calibration_date=NA
!
! COMMENTS
!
! Citation: Cite your paper where your data are published
!
/missing=-9999.
/delimiter=comma
/fields=station,date,time,lon,lat,depth,cloud,RelAz,AOT,spm,Chla,Rrs355,Rrs360,Rrs365,Rrs370,Rrs375,Rrs380,Rrs385,Rrs390,Rrs395,Rrs400,Rrs405,Rrs410,...
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/end_header
TestStation001,20210815,11:30:00,0,0,0.01,0,134.7,0.2444,0.1,0.1,0.001886946,0.002068008,0.002167035,0.002305759,0.002504616,0.002699149,0.002943716,0.003166,...
TestStation002,20201014,11:55:00,-32.6232,32.0859,0.01,0,134.8,0.2388,0.1,0.1,0.002158972,0.002363762,0.00247761,0.00264967,0.002880799,0.003116844,0.0034196,...
TestStation003,20201014,12:16:00,-32.0209,26.9584,0.01,0,134.7,0.2388,0.1,0.1,0.001918189,0.002097384,0.002191946,0.002353893,0.002567901,0.002792078,0.00307,...
TestStation004,20210910,09:40:00,3,-3,0.01,0,134.9,0.2388,0.1,0.1,0.001271305,0.001359205,0.00139314,0.001432681,0.001487187,0.00153414,0.00160502,0.00165816,...
TestStation005,20210910,09:54:00,-4,4,0.01,0,134.8,0.277,0.1,0.1,0.00123858,0.001313013,0.001336158,0.00136599,0.001412448,0.001450581,0.001508596,0.00155277,...
TestStation006,20210910,10:07:00,5,-5,0.01,0,134.8,0.277,0.1,0.1,0.001126482,0.001192422,0.001211226,0.001237373,0.001276362,0.001307301,0.00135953,0.0013975,...

```

SeaBASS
seabass.gsfc.nasa.gov

Inter-operable

OCDB
ocdb.eumetsat.int



at.int



```

/begin_header
/investigators=TestPI
/affiliation=TestAffiliation
/contact=TestContact@TestInstitution.org
/received=20190101
/processed=20190101
/experiment=TestExperiment
/cruise=TestCruise
/station=NA
/data_file_name=TestOCDBsubmission.txt
/documents=see_comments
/calibration_files=see_comments
/data_type=cast
/data_status=final
/water_depth=NA
/BRDF_correction=M02
/instrument_model=RAMSES
/instrument_manufacturer=TriOS
/calibration_date=NA
!
! COMMENTS
!
! Citation: Cite your paper where your data are published
!
/missing=-9999.
/delimiter=comma
/fields=station,date,time,lon,lat,depth,cloud,RelAz,AOT,spm,Chla,Rrs355,Rrs360,Rrs365,Rrs370,Rrs375,Rrs380,Rrs385,Rrs390,Rrs395,Rrs400,Rrs405,Rrs410,...
/units=none,yyymmdd, hh:mm:ss,degrees,degrees,m,%,degrees,unitless,mg/L,mg/m^3,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,1/sr,...
/end_header
TestStation001,20210815,11:30:00,0,0,0.01,0,134.7,0.2444,0.1,0.1,0.001886946,0.002068008,0.002167035,0.002305759,0.002504616,0.002699149,0.002943716,0.003166,...
TestStation002,20201014,11:55:00,-32.6232,32.0859,0.01,0,134.8,0.2388,0.1,0.1,0.002158972,0.002363762,0.00247761,0.00264967,0.002880799,0.003116844,0.0034196,...
TestStation003,20201014,12:16:00,-32.0209,26.9584,0.01,0,134.7,0.2388,0.1,0.1,0.001918189,0.002097384,0.002191946,0.002353893,0.002567901,0.002792078,0.00307,...
TestStation004,20210910,09:40:00,3,-3,0.01,0,134.9,0.2388,0.1,0.1,0.001271305,0.001359205,0.00139314,0.001432681,0.001487187,0.00153414,0.00160502,0.00165816,...
TestStation005,20210910,09:54:00,-4,4,0.01,0,134.8,0.277,0.1,0.1,0.00123858,0.001313013,0.001336158,0.00136599,0.001412448,0.001450581,0.001508596,0.00155277,...
TestStation006,20210910,10:07:00,5,-5,0.01,0,134.8,0.277,0.1,0.1,0.001126482,0.001192422,0.001211226,0.001237373,0.001276362,0.001307301,0.00135953,0.0013975,...

```

You can use Excel to bring your data to this format...
However...



Usage. Step ins

file – editing with Excel...

copernicus.eumetsat.int

ThoMaS deals with these ...

20210916_AnaDelgado.sb - Notepad

File Edit Format View Help

```

/begin_header
/investigators=Ana_Lau
/affiliations=Institut
/contact=aldelgado@iadi
/experiment=Monte_Herm
/cruise=Pescadores
/documents=lom.2012.10
/calibration_files=NA
/data_type= bottle
/data_status=final
/water_depth= 0
/wavelength_option=NA
/instrument_model=NA
/instrument_manufactu
/calibration_date=NA
/cloud_percent=NA
/secchi_depth=NA
/wave_height=NA
/wind_speed=NA
!
! COMMENTS
! For this cruise, Tot
! Water samples were f
! The optimal filtered
! The Whatman GF/F fil
! pre-weighed and rins
! The filters were onc
!
!
/missing=-999.
/delimiter=comma
/fields=time,lat,lon,station,spm,date
/units=hh:mm:ss,degrees,degrees,none,mg/L,yyyymmdd
/end_header
14:30:00,-38.790,-62.280,1,156,20170901

```

Text Import Wizard - Step 1 of 3

The Text Wizard has determined that your data is Fixed Width.

If this is correct, choose Next or choose the data type that best describes your data.

Original data type

Choose the file type that best describes your data:

Delimited - Char

Fixed width - Field

Start import at row: 1

My data has headers.

Preview of file C:\Users\Gost...

1	/begin_header
2	/investigators=Ana
3	/affiliations=Inst
4	/contact=aldelgado
5	/experiment=Monte
6	/cruise=Pescadore
7	/documents=lom.20

20210916_Ana

File Home Insert Page Layout Formulas Data

Clipboard Font

Calibri 11

B I U

A1

A1	/begin_header
2	/investigators=Ana Laura Delgado
3	/affiliations=Instituto Argentino de Oceanografia
4	/contact=aldelgado@iadi-conicet.gob.ar
5	/experiment=Monte_Hermoso
6	/cruise=Pescadores
7	/documents=lom.2012.10.1011
8	/calibration_files=NA
9	/data_type= bottle
10	/data_status=final
11	/water_depth= 0
12	/wavelength_option=NA
13	/instrument_model=NA
14	/instrument_manufacturer=NA
15	/calibration_date=NA
16	/cloud_percent=NA
17	/secchi_depth=NA
18	/wave_height=NA
19	/wind_speed=NA
20	!
21	! COMMENTS
22	! For this Total Suspended Matter was sourced from surface water samples taken w
23	! Water samples were filtered immediately after the extraction following the protocol
24	! The op ranging from 0.5 l to 2 l.
25	! The Whatman GF/F filters used were pre-combusted at 500 Â°C for 4 hours
26	! pre-wei and dried at 65 Â°C until a constant weight was observed.
27	! The filters were once more weighed before the filtrations occurred.
28	!
29	!
30	/missing=-999.
31	/delimiter=comma
32	/fields=ti lat lon station spm date
33	/units=hh:mm:ss,degrees,degrees,none,mg/L,yyyymmdd
34	/end_header
35	14:30:00 -38.79 -62.28 1 156 2E+07
36	12:20:00 -38.814 -62.22 2 32 2E+07
37	12:55:00 -38.799 -62.264 3 49 2E+07
38	14:30:00 -38.775 -62.331 4 47 2E+07
39	14:15:00 -38.742 -62.331 5 75 2E+07
40	15:32:00 -38.751 -62.383 6 42 2E+07
41	15:00:00 -38.864 -62.216 7 28 2E+07
42	16:00:00 -38.888 -62.19 8 36 2E+07
43	17:00:00 -38.89 -62.191 9 34 2E+07
44	18:00:00 -38.882 -62.201 10 31 2E+07
45	19:00:00 -38.864 -62.216 11 37 2E+07
46	13:00:00 -38.79 -62.28 12 84.1 2E+07
47	13:30:00 -38.79 -62.28 13 51.5 2E+07
48	14:00:00 -38.79 -62.28 14 58.4 2E+07
49	15:00:00 -38.79 -62.28 15 135.4 2E+07
50	16:00:00 -38.79 -62.28 16 412.3 2E+07
51	13:00:00 -38.79 -62.28 17 200 2E+07

20210916_AnaDelgado

File Edit Format View Help

```

/begin_header,,,,,
/investigators=Ana Laura Delgado,,,,,
/affiliations=Instituto Argentino de Oceanografia,,,,,
/contact=aldelgado@iadi-conicet.gob.ar,,,,,
/experiment=Monte_Hermoso,,,,,
/cruise=Pescadores,,,,,
/documents=lom.2012.10.1011,,,,,
/calibration_files=NA,,,,,
/data_type= bottle,,,,,
/data_status=final,,,,,
/water_depth= 0,,,,,
/wavelength_option=NA,,,,,
/instrument_model=NA,,,,,
/instrument_manufacturer=NA,,,,,
/calibration_date=NA,,,,,
/cloud_percent=NA,,,,,
/secchi_depth=NA,,,,,
/wave_height=NA,,,,,
/wind_speed=NA,,,,,
!,,,,,
! COMMENTS,,,,,
! For this cruise, Total Suspended Matter was sourced from surface water :
! Water samples were filtered immediately after the extraction following :
! The optimal filtered volume was determined according to the obtained tu
! The Whatman GF/F filters used were pre-combusted at 500 Â°C for 4 hours.
! pre-weighed and rinsed with at least 250 ml milli-Q water to eliminate :
! The filters were once more weighed before the filtrations occurred.,,,,,,
!,,,,,
!,,,,,
/missing=-999.,,,,,,
/delimiter=comma,,,,,
/fields=time,lat,lon,station,spm,date
/units=hh:mm:ss,degrees,degrees,none,mg/L,yyyymmdd
/end_header,,,,,
14:30:00,-38.79,-62.28,1,156,20170901

```



Usage. Step SatData

EUMETSAT Data Store

EUMETSAT DATA SERVICES
Product Navigator / Search results

OLCI [X]

PLATFORM [v]
 Sentinel-3 (36)

SENSOR TYPE [v]
 Optical (36)

SENSOR [v]
 OLCI (36)
 SLSTR (4)

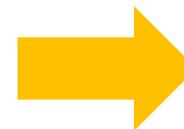
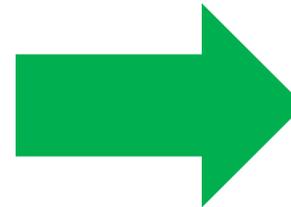
PROCESSING LEVEL [v]
 Level 1 Data (7)
 Level 2 Data (12)

We've found 36 results

OLCI Level 1B Reduced Resolution in NRT - Sentinel-3 [LEO]
View · Download · Order · Subscribe
OLCI (Ocean and Land Colour Instrument) Reduced resolution: 1200m at nadir. All Sentinel-3 NRT products are available at pick-up point in less than 3h. Level 1 products are calibrated Top Of Atmosphere radiance values at OLCI/21 spectral bands. Radiances are computed from the instrument digital ...

OLCI Level 1B RGB - Sentinel-3B [LEO]
View · Download · Order · Subscribe
This product is an RGB (Red, Green, Blue) composite based upon data from S3B single swath OLCI L1 NRT products Top-Of-Atmosphere (TOA) radiometric measurements, radiometrically corrected, calibrated and spectrally characterised. The product is composed from data from a combination of the following ...

eumdac



Your local system

- S3A_OL_2_WFR___20190409T103146_20190409T1...
- S3A_OL_2_WFR___20190410T100835_20190410T1...
- S3A_OL_2_WFR___20190413T102802_20190413T1...
- S3A_OL_2_WFR___20190502T103533_20190502T1...
- S3A_OL_2_WFR___20190529T103533_20190529T1...
- S3A_OL_2_WFR___20190530T101222_20190530T1...
- S3A_OL_2_WFR___20190618T101650_20190618T1...
- S3A_OL_2_WFR___20190828T093836_20190828T0...
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- S3A_OL_2_WFR___20190922T102801_20190922T1...
- S3A_OL_2_WFR___20190923T100450_20190923T1...
- S3A_OL_2_WFR___20190924T093839_20190924T0...
- S3A_OL_2_WFR___20190926T102417_20190926T1...
- S3A_OL_2_WFR___20190927T100106_20190927T1...
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- S3A_OL_2_WFR___20191008T101604_20191008T1...
- S3A_OL_2_WFR___20191012T101220_20191012T1...
- S3A_OL_2_WFR___20191015T103147_20191015T1...
- S3A_OL_2_WFR___20191016T100836_20191016T1...
- S3A_OL_2_WFR___20191017T094225_20191017T0...
- S3A_OL_2_WFR___20191019T102802_20191019T1...
- S3A_OL_2_WFR___20191027T102033_20191027T1...
- S3A_OL_2_WFR___2019112T100834_2019112T1...

Thursday, 4 July 2002 through Wednesday, 8 May 2024

Chlorophyll a

Select one or more regions:
AdriaticSea, AegeanSea, Antarctic, Antarcctica, ArabianSea, Arctic, Australia, AustraliaCoast, Azores, Bahamas, BalticSea

Select only scenes having in situ matchups.

Display results 10 at a time. [Reconfigure page]

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2002												
2003												
2004												
2005												
2006												
2007												
2008												
2009												
2010												
2011												

+ SatData Lists matching in situ

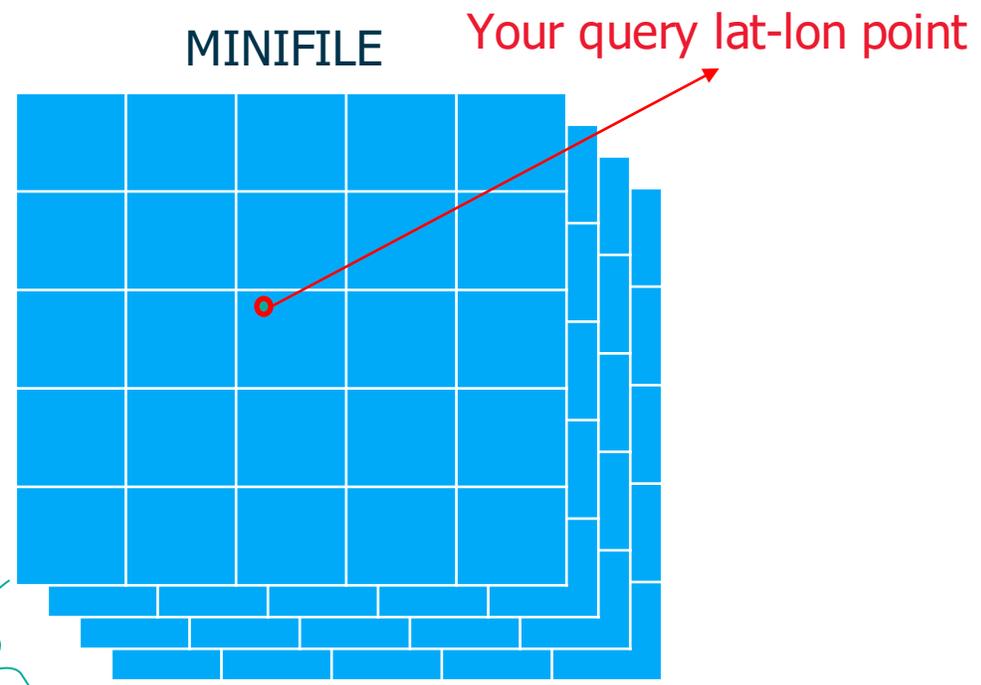


- S3A_OL_2_WFR_____20190409T103146_20190409T1...
- S3A_OL_2_WFR_____20190410T100835_20190410T1...
- S3A_OL_2_WFR_____20190413T102802_20190413T1...
- S3A_OL_2_WFR_____20190502T103533_20190502T1...
- S3A_OL_2_WFR_____20190529T103533_20190529T1...**
- S3A_OL_2_WFR_____20190530T101222_20190530T1...
- S3A_OL_2_WFR_____20190618T101650_20190618T1...
- S3A_OL_2_WFR_____20190828T093836_20190828T0...
- S3A_OL_2_WFR_____20190830T102413_20190830T1...
- S3A_OL_2_WFR_____20190831T100103_20190831T1...
- S3A_OL_2_WFR_____20190903T102030_20190903T1...
- S3A_OL_2_WFR_____20190904T095719_20190904T1...
- S3A_OL_2_WFR_____20190907T101646_20190907T1...
- S3A_OL_2_WFR_____20190918T103145_20190918T1...
- S3A_OL_2_WFR_____20190919T100834_20190919T1...
- S3A_OL_2_WFR_____20190922T102801_20190922T1...
- S3A_OL_2_WFR_____20190923T100450_20190923T1...
- S3A_OL_2_WFR_____20190924T093839_20190924T0...
- S3A_OL_2_WFR_____20190926T102417_20190926T1...
- S3A_OL_2_WFR_____20190927T100106_20190927T1...
- S3A_OL_2_WFR_____20191004T101649_20191004T1...
- S3A_OL_2_WFR_____20191005T095338_20191005T0...
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- S3A_OL_2_WFR_____20191012T101220_20191012T1...
- S3A_OL_2_WFR_____20191015T103147_20191015T1...
- S3A_OL_2_WFR_____20191016T100836_20191016T1...
- S3A_OL_2_WFR_____20191017T094225_20191017T0...
- S3A_OL_2_WFR_____20191019T102802_20191019T1...
- S3A_OL_2_WFR_____20191027T102033_20191027T1...
- S3A_OL_2_WFR_____20191112T100834_20191112T1...



Horizontal extension = 5 px

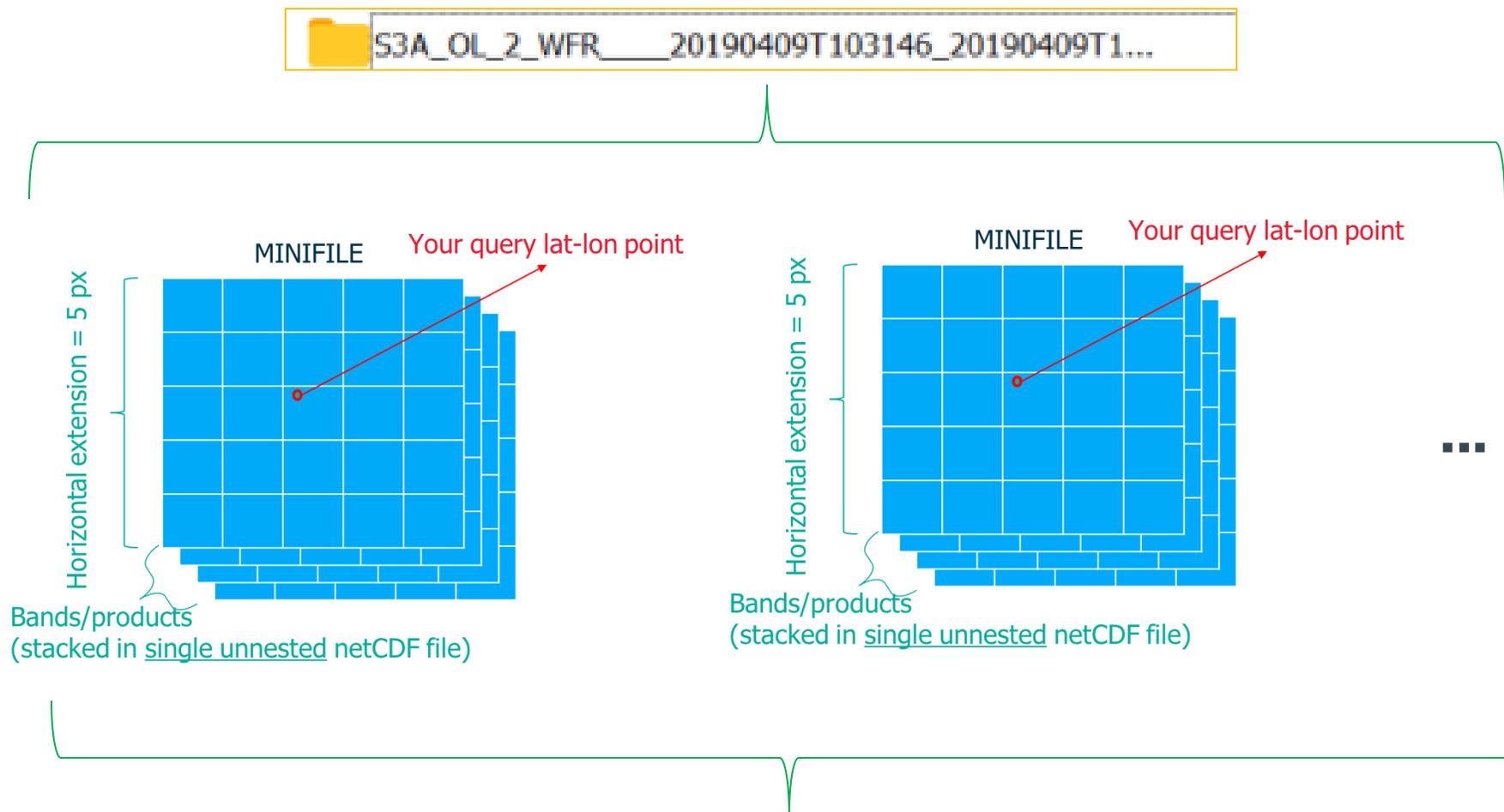
Bands/products (stacked in single unnested netCDF file)



ThoMaS uses the minimisation of the orthodromic distance approach to find the centroid of the window
Satellite products are not altered at all at this step, with the exception of some OLCI geometries...



Usage. Option download_extract_delete



S3A_OL_2_WFR_..._20190409T103146_20190409T1...

EUMETSAT PROGRAMME OF THE EUROPEAN UNION **Copernicus**
www.eumetsat.int

Anna-Lena Erdmann, Hayley Evers-King, Claudio Vasile Nagy, Juan Ignacio Gascón

Bringing User Software to the Cloud to Scale up Earth Observation Data Processing – Demonstrating a Cloud-Implementation of the ThoMaS Software for Satellite Validation with *in situ* Data

Many Earth Observation (EO) users face barriers due to limited local computing power and slow data downloads. By moving user-developed EO processing workflows to the cloud using the WEkEO serverless framework eocanvas, users can process data close to the source and drastically reduce data transfer needs. This poster presents an initial use case with the ThoMaS software to highlight the benefits and invite collaboration on similar cloud-based EO applications.

INTRODUCTION

THE PROBLEM

- Large amounts of EO data
- Limited Computational Resources
- Low Bandwidth

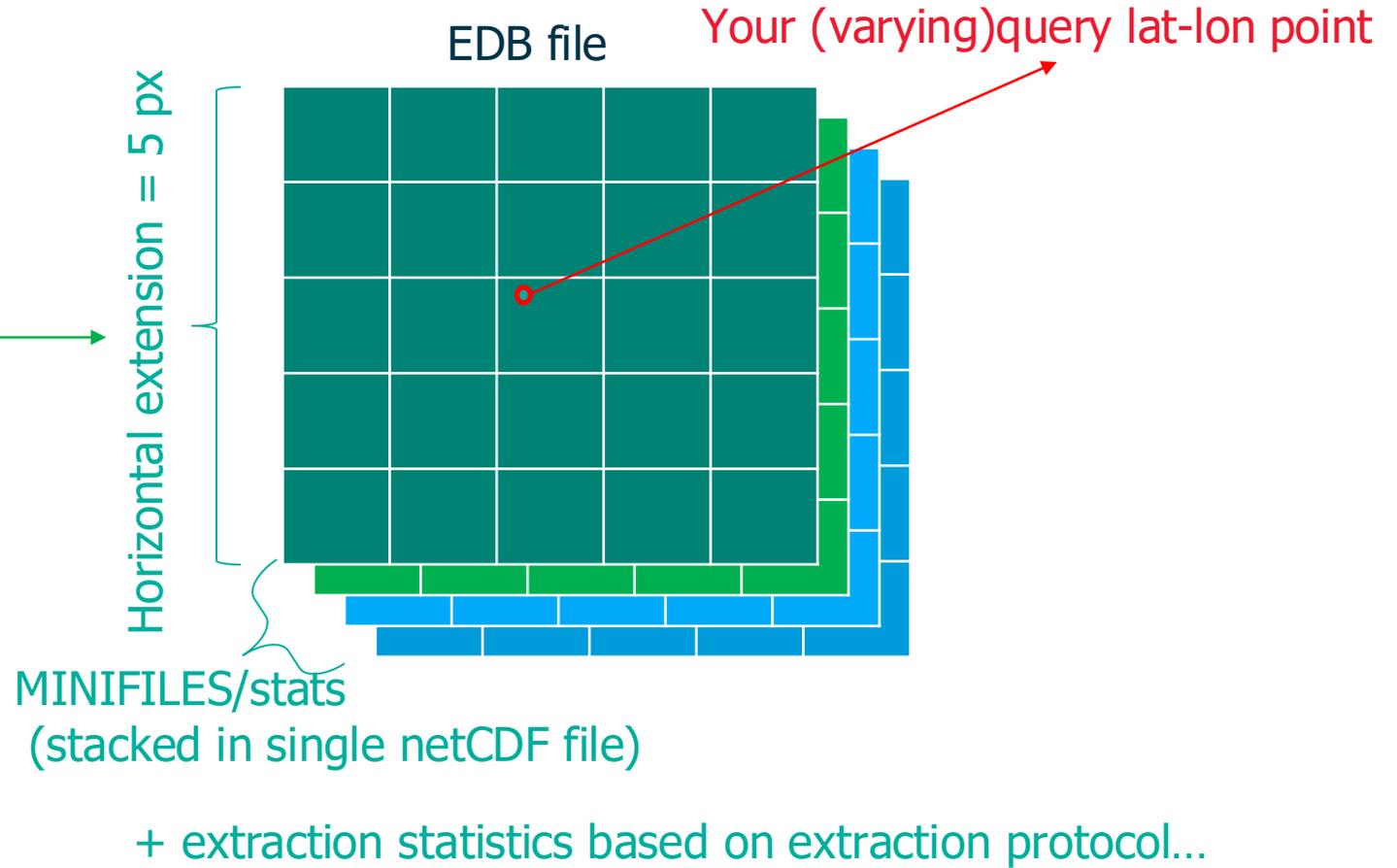
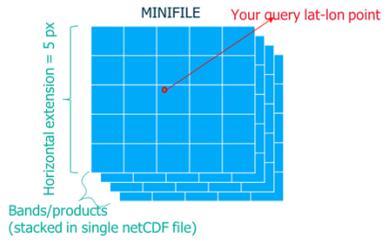
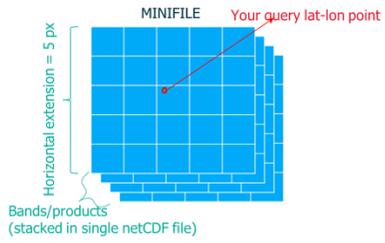
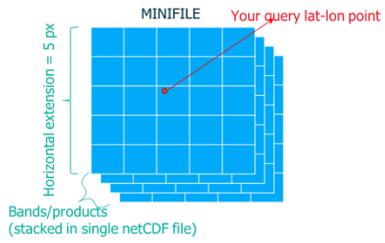
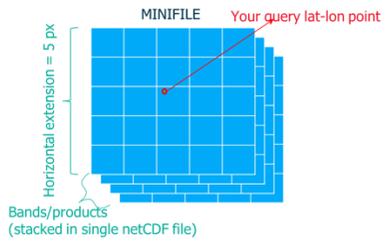
EOCANVAS – CLOUD BASED PROCESSING OF EO DATA

The eocanvas is the WEkEO service for cloud-based earth processing of Copernicus earth Observation (and more) data.

Key features:

- Deploy (any) software on the cloud
- No data download – the data processing is happening in the cloud
- Download only the results
- Bring your own data on a S3 bucket

(The poster also includes QR codes for GitHub, LinkedIn, and contact, and a detailed flowchart of the cloud processing architecture.)



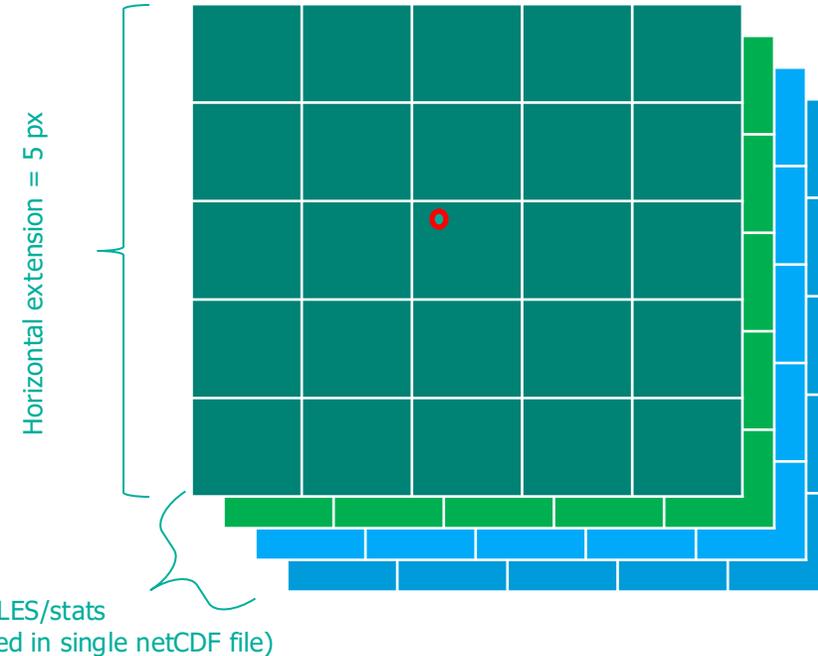
MDB file

1. Merging insitu and extractions according to matchup pairs
2. Statistical metrics calculated + scatter/spectral plots

In situ data base (IDB) file

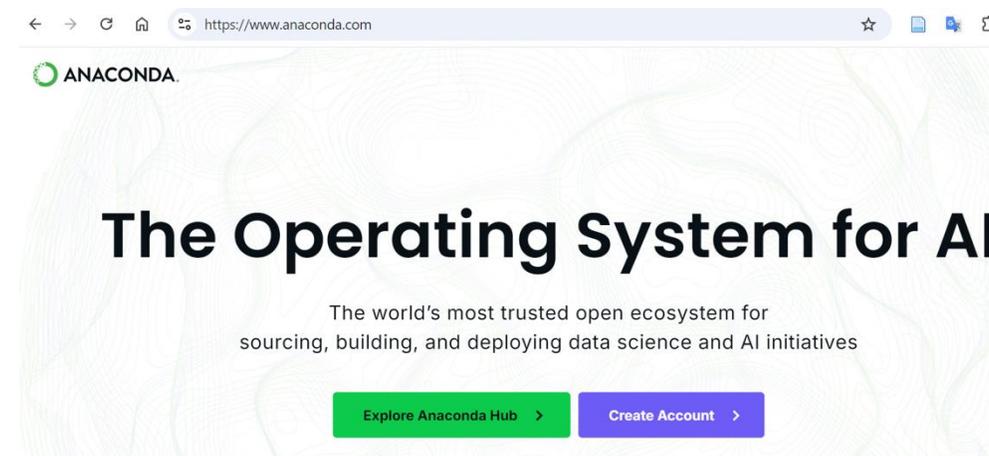


Extraction data base (EDB) file



MDB: indexed by matchup pair ID
Time interpolation (nearest in time) applicable

1. Apart from that background knowledge...
2. Install the latest Anaconda Python distribution.
3. Install git





- Git way:

```
cd ~  
mkdir ThoMaS  
cd ThoMaS  
git clone --depth 1 https://gitlab.eumetsat.int/eumetlab/oceans/ocean-science-studies/ThoMaS .
```

- Direct download:

<https://gitlab.eumetsat.int/eumetlab/oceans/ocean-science-studies/ThoMaS>

Recent updates were done on the code

```
git pull
```



- Once conda and ThoMaS are installed, create the thomas env:

```
cd ~  
cd ThoMaS  
conda env create -f environment.yml  
conda activate thomas
```

libmamba is the best choice for those of you who are stuck in the “Solving environment step”



1. EUMETSAT Data Store/OBPG credentials obtained and stored?
2. (optional) ECMWF ADS/CDS credentials obtained and stored?
3. ThoMaS code cloned?
4. thomas conda environment set up and activated?
5. Required inputs in place? (config_file.ini, insitu input file?)



If **YES**.. run by executing this command:

```
python /path/to/ThoMaS/main.py -cf /path/to/config_file.ini
```

Or to run in GUI mode:

```
python /path/to/ThoMaS/main.py
```

